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CARNEGIE MUSEUM

VOL. III

W. J. HOLLAND, *Editor*

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PREFATORY NOTE

The first paper in the present volume of the Memoirs, from the pen of Prof. C. V. Hartman, embodying some of the results of his researches upon the Pacific Coast of Costa Rica, was published in the summer of 1907. It had been intended to immediately follow it by a monographic paper upon the Osteology of the Chalicotheres, but the fact that new discoveries of material had been made, and ever-multiplying cares and duties on the part of the writer, prevented the immediate execution of this purpose. The matter was long held in abeyance, and it was not until the summer and fall of 1913 that it became possible to bring the second memoir to a conclusion. It is now presented to the attention of students in the belief that it will be found to supply more complete information in regard to this subject than is contained in any treatise which has thus far been published.

W. J. Holland.

Carnegie Museum,
January, 1914.

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MEMOIRS

OF THE

CARNEGIE MUSEUM

VOL. III NO. 1.

W. J. HOLLAND, EDITOR

ARCHEOLOGICAL RESEARCHES ON THE PACIFIC COAST OF COSTA RICA

BY

C. V. HARTMAN

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MEMOIRS

OF THE

CARNEGIE MUSEUM.

VOL. III. NO. 1.

ARCHEOLOGICAL RESEARCHES ON THE PACIFIC COAST OF COSTA RICA.

By C. V. Hartman.

PREFATORY NOTE.

In the beginning of the year 1903 I had the good fortune to be called to assume the Curatorship of the Section of Ethnology and Archeology at the Carnegie Museum in Pittsburgh, and shortly afterwards I laid before the Director of the institution, Dr. W. J. Holland, a plan to resume the archeological investigations I had previously started in Costa Rica. My proposal was approved and a liberal appropriation was made for the work.

My former investigations in Central America were carried out under the auspices of the Swedish Anthropological Society and embraced archeological and ethnological work in the Republics of Costa Rica, Salvador, and Guatemala during three years, 1896–1899. The collections made during this exploration were afterwards presented to the Royal Ethnographical Museum by my countryman, Mr. Åke Sjögren, who had supplied the funds for the field-work and for a publication, which I in the year 1901 issued at that Museum under the title "Archæological Researches in Costa Rica." In this volume are embodied the main results of the archeological investigations on the Atlantic coast and the upland districts of Costa Rica.

At the time of my departure from Puntarenas, however, I made up my mind to return some day in the future in order to more thoroughly follow up the promising

investigations there started. The splendid facilities offered by the Carnegie Museum made it possible for me to continue the work in Costa Rica, and obtain additional data and material.

In March 1903 I went down to Costa Rica for the second time and spent altogether seven months in archeological researches in various parts of the republic. During this stay I revisited several of the localities described in my previous work and carried on excavations at Las Guacas on the Pacific slope and at three newly discovered sites of burial grounds on the plains of the highlands. On the Atlantic coast my stay was limited to a short visit to the ancient settlement of Mercedes. One of the results obtained during my sojourn in Costa Rica was the purchase for the Carnegie Museum of the three largest private collections ever made in that country, two of these being the property of Padre José Maria Velasco of Santa Cruz, representing the cultures of the Pacific Coast, the third belonging to the estate of Sr. Don Juan Troyo of Cartago, containing objects from the highlands. To these were added several smaller purchases. Altogether the archeological material thus secured for the Carnegie Museum exceeds in number and types that of all other museums combined, save only the collection of the National Museum of Costa Rica at San José.

In this and forthcoming Memoirs I propose to present not only the principal results obtained during my own work in the field in Costa Rica, but also to supplement these with illustrations and descriptions of a series of the most important types of the ancient artefacts, selected from the extensive collections I purchased for the Carnegie Museum, and also from the rich material of the Museo Nacional in San José, which by the courtesy of the Director of the latter institution was placed at my disposal for study and reproduction. I thus hope to make accessible to the student of American archeology and art a selection of the most interesting ancient artefacts which have been brought to light by myself as well as by others in this comparatively little known part of Central America.

In the present Memoir after a short historical introduction, there are given the observations and results obtained during my own excavations in the fall of 1903 at Las Guacas, the most important ancient cemetery as yet discovered on the Pacific Coast of Costa Rica. Then follows an account of a representative selection of the various stone implements contained in the collections which Padre J. M. Velasco previously had obtained at the same place. This part deals with implements of stone which are classified in two groups: (1) *Tools and weapons,* as metates, celts, axes, bark-scrapers, polishing-stones, and various other objects of a utilitarian character; (2) *Objects of ornamental and ceremonial use,* as banner-stones or maces, amulets, tubes, beads, ear-plugs, and various other small stone artefacts.

In a second Memoir it is my wish to describe ceramics representing the "Las Guacas" culture, and also to illustrate the articles made of metal, shell, bone, and other material, which have been unearthed.

It is with satisfaction and the greatest pleasure that I use this opportunity to acknowledge my indebtedness and thankfulness for the courteous treatment and hospitality shown me everywhere during my travels in Costa Rica by the cultivated inhabitants of this prosperous and peaceful republic. Special thanks for the assistance and information accorded me are due to the Minister of Public Instruction, Dr. Leonidas Pacheco, who provided me with the most effective letters of recommendation to the civil authorities, to Professor H. Pittier de Fabrega, Director of the National Museum, Messrs. Minor C., and John Keith of the United Fruit Company for the gift of valuable archeological specimens and other courtesies, the Costa Rica Railroad Company for shipping facilities, Sr. Don Mauro Fernandez, President of the Costa Rica Bank, Mr. Charles Ahl, Professor Pablo Biolley, Sr. Don Anastasio Alfaro, the late Dr. Juan F. Ferraz, Count v. Braida, Dr. José C. Zeledon, Sr. Don Juan Cooper, Sr. Don José Angel Troyo, Consul Felix Wiss, Mr. Alfred Brade, the Rev. J. M. Velasco, Sr. Don Saturnino Lizano, the Governor of Puntarenas, Srs. Don Juan J. Matarrita, Don Antonio Carillo, and several others, not named, but not forgotten. During the progress of this work I obtained the favor of the loan of a number of archeological specimens, principally objects of jade from Mexico, which have been reproduced for comparison. For this courtesy I am indebted to the owner, Mr. George G. Heye of New York City. Finally my most sincere thanks are due to the Director of the Carnegie Museum, Dr. W. J. Holland, not only for the facilities he gave me for prosecuting this work, but also for his kindness in revising the manuscript and his editorial supervision of the paper during its progress through the press.

I. ORIGINAL RESEARCHES OF THE WRITER AT LAS GUACAS, IN THE PENINSULA OF NICOYA.

1. Discovery and Early History of Nicoya.

On the 25th of September, 1513, Vasco Núñez de Balboa discovered, and on the 29th he took formal possession of the Pacific Ocean for the Spanish Crown.

In the year 1519 Pedrarias Dávila, the Governor of Castilla del Oro, founded Panama and began to devote special attention to the exploration of the Pacific Coast. He sent Captain Gaspar de Espinosa northward with some ships to make discoveries along the coast. Espinosa reached the province of Burica, a little more than one hundred leagues from Panama, and from this point he returned by land

One ship, however, was sent further, and reached the entrance of the Gulf of San Lucar or Nicoya. Later on Espinosa sent out Captain Hernán Ponce de Leon with two ships and a crew of forty men, and they, following the coast, entered the same bay, which they described as being more than twenty leagues in length, filled with islands and forming a fine, well protected port, leading to the rich and beautiful province of Nicoya. In the gulf the Spanish ships were surrounded by a large number of canoes filled with armed men and on the shores were seen numbers blowing trumpets and horns and making threats and hostile signs, but after a few gunshots had been fired they all disappeared, not one being seen either on sea or land. As Hernán Ponce concluded that he could accomplish nothing further of advantage at that time, he returned to Panama.

In 1522 Gil Gonzáles de Ávila traversed all the territory of Costa Rica from ocean to ocean and then visited the island of Chira in the Gulf of Nicoya.

The following year Francisco Fernándes de Córdova, the conqueror of Nicaragua, founded the city of Bruselas near the Gulf of Nicoya, this being the first colony established in Costa Rica. As was customary at that time, the Indians of the surrounding provinces, Nicoya, Chira, and Güetares, were distributed among the residents of the colony.

In 1527 Pedrarias Dávila was nominated Governor of the province of Nicaragua without any definite limits to his territory, but in fact he had under his command all the Indians of Nicoya, Chira, and other districts of the Gulf.

In 1529 the historian, Gonzalo Fernándes de Oviedo y Valdés, visited the pueblo and Gulf of Nicoya. From his pen we have the most complete and satisfactory early description of the manners and customs of the Indians of Nicoya and those of the islands of the Gulf. Only the principal details can here be given.

The men were either naked or wore a breech-cloth made of a belt of cotton. The women also used belted breech-cloths and besides, in some parts, sleeveless cotton shirts. The belts were adorned with designs in many colors. The men wore their hair either in one braid hanging down the back, or tied together in a knot standing straight up from the crown. The women also wore the hair in the latter way, but more usually parted in the middle, and laid up in a large knot above each ear. As ornaments these Indians used necklaces of beads made of "pie de burro" (*Carica* sp.) and other sea-shells. They also used labrets of bone, or hammered gold. These labrets could be removed when they took their meals. Their arms were decorated with tattooings principally representing the jaguar. They were fine archers, used spears and clubs, and in time of war trumpets and horns. The walls of the houses were of poles, and the roofs were thatched with palm-leaves.

In the interior they had small benches called "duhos." They used canoes and rafts of poles on the Gulf, making their living to a great extent by fishing. Oysters and other shell-fish were among their principal foods. The large flat shells of the pearl-oysters were inserted in double rows as oarblades and were also used as shovels for work in the fields. They were great hunters, principally killing deer and wild hogs. They planted corn and beans of various kinds, and had large plantations of cacao and other fruit-trees. Cacao was copiously used at their feasts, being colored with the red seeds of the *achiote*, or arnotto (*Bixa orellana* Linnæus), so that it resembled blood. At the festivals an intoxicating beer of corn was also copiously used and the rolled leaves of tobacco were smoked. On the island of Chira it is especially mentioned that the Indians made "very fine pottery, as pitchers and plates, cups, vases, and other vessels, all beautifully shaped, black as fine velvet, highly polished, of jet lustre, well worthy to be used as gifts for princes."

All their villages in the middle had squares, or market-places, for the sale of commodities. On the squares near the sacrificial mound were erected their temples and small houses for the idols, of which they had a great number, made either of clay or wood. They set apart for their gods special festival-days, celebrated with dances and songs especially during the time of the cacao- and bean-harvests. In Nicoya, three times a year, on days considered as great festival-days, the cacique of Nicoya, his principal chiefs, and most of the people, both men and women, decked out with a great display of feathers, and adorned and painted in their peculiar fashion, performed a dance consisting of counter-paces in a circle. The women grasping each other by the hands, or hooking arms, formed a circle around the sacrificial mound and at an interval of four or five steps the men formed another circle around them. In the aisle thus formed between them other Indians walked back and forth serving the dancers with drinks. Both men and women made swaying motions with their bodies and heads and drank the beer without stopping the motion of their feet. This dance was continued for four hours or more in front of their great temple on the principal square. At its conclusion the man or woman previously chosen for sacrifice was led to the top of the mound, his left side opened, his heart was torn out and the first drops of the blood were sacrificed to the sun. Immediately afterwards the victim and four or five others were beheaded on a stone placed on the top of the mound and their blood offered up to the idols and gods. The priests or executioners then anointed their lower lips and faces with the blood. Finally the bodies were thrown down the slope of the mound, and afterwards taken up and eaten as sacred and very precious food. At the moment the sacrifice was

finished all the women present raised a loud cry and fled to the woods and mountains hiding themselves.

The ceremonies and rites thus resembled those of the Mexicans, the stage of civilization being barbaric. These Indians, like the Mexicans, had folded books made of parchment of deer skin. In these they painted characters and figures in red or black ink, which 'although neither print nor script,' represented very clearly whatever they wished to record. In such books they had depicted their boundary lines, landed property, roads, rivers, mountains, woods, etc., in order thereby to determine these things in time of dispute, or litigation.

The form of government in these parts is described as differing very much in various localities. The messengers and army officers were always believed on their word. They carried in the hand a fan made of plumes. On the islands in the gulf, however, a long staff served the purpose. On the top of the staff there was a hollow shell with small pebbles inside Fixing the lower end of this staff in the ground of the market-place, the messenger swung it back and forth producing a loud noise, and, calling on the people, he delivered his message.

As a rule a man had only one wife, but some had more, especially the chiefs. The caciques had as many as they desired and were entitled to the *jus primæ noctis.*

The largest island of the gulf, Chira, is described by Gil Gonzalez at the time of his visit as being about seven or eight leagues in circumference and as having a population of more than five hundred warriors of full age, not to mention the old men, women, and children. In front of the island of Cachoa, now the island of Venado, was the people and province of Orotiña ; more to the east the people and province of Chorotegua ; and on the opposite side, more to the north and north-east, were the sierras and peoples called Güetares. The latter were said to be very numerous and to extend along the coast of the gulf to the frontier of the Choroteguas.

Oviedo gives the following vivid description of one of the feasts of the Choroteguas : "There are other dances in connection with which drinking is common, at which the wine is as frequent as the singing, until the participants drop dead-drunk stretched out upon the ground like hides (hechas cuéros). And many of those, who thus get intoxicated, remain where they happen to fall, until the effect of the wine is gone the next day. Any one seeing a companion fall rather envies than pities him, because they do not go to the feast to dance, but for the pleasure of getting drunk. Moreover, I would say, that in truth I and a priest and three or four other Spaniards who were present, would have preferred to be far away when we saw these seventy or eighty Indians with their chief drunk and a whole people so beastly and idolatrous and so steeped in vices. I am convinced that those Indians who are Christians

find no satisfaction in the truth, because, instead of being masters as they originally were, they have now been made slaves, and in their rites, ceremonies, and vices they have been encouraged. What can you expect from their friendship? Furthermore we were far from the succor and help of the Christians, and in the house of one of the chiefs of that tribe, and in a country, where the people can with impunity make attacks by land and sea against whomsoever they wish. All these things disposed us to fear. It is true that one of the caciques, who has boasted most of the friendship of the Spaniards, is the one called Nicoya, and as baptized D. Alonso, but whose Indian name is *Nambi*. When we asked him for some Indians, whose services we needed, he said: 'I have no Indians, but Christians, and if you desire Christians, I shall place them at your disposal.' We replied 'Then send us some Christians, who can do what we want.' Presently he sent us as many Indians as requested and they did what they were ordered to do."

But listen now to what follows concerning the baptism of this cacique and what his people did. It is as follows:

"On Saturday the 19th of August, 1529, the cacique D. Alonso of the province of Nicoya, who was also called Nambi, which in his native tongue, the Choroteguan, signifies *dog*, sat down on a 'duho' or small bench in the square of Nicoya, much pleased and happy, together with his most prominent men and about seventy or eighty other Indians on two other benches. Then in another part of the same square about two hours before dark eighty or a hundred Indians, who doubtless belonged to the common people, began to sing and dance in a circle. A girl then began to serve them in jicara-cups a drink made of maize, very strong and somewhat sourish, resembling in color chicken-broth, when the yolk of one or two eggs is mixed with it. And, as they began to drink, the same cacique drew forth a handful of tobacco-rolls about four inches long and as thick as a finger and made of a certain leaf rolled up and tied together with threads of the cabuya-fiber. This tobacco-plant is grown with great care on account of the effect of the leaves, and they light the roll at one end and smoke it like a pipe until it ceases burning, which may last a day. Now and then they put the end opposite the fire into the mouth and inhale the smoke for a short while, and then blow it out through the mouth and nostrils. Each of the Indians I have mentioned had one of these rolled-up leaves, which they call '*yapoquete*' and in the language of the island Haiti, or Española, '*tabacco*.'

"And the Indians, both men and women, continued to drink the above-mentioned beverage, going and coming with it, and in the course of this drinking there were brought large cups of cacao prepared as they are accustomed to drink it. Of this, however, they took only two or three draughts, passing it from hand to hand,

while they smoked, beat a kettle-drum, and danced. In this manner the feast went on till midnight, when the greater part of them fell senseless to the ground, dead-drunk. As intoxication affects men differently, some of them seemed to sleep motionless, others staggered around weeping, shouting, or kicking about them desperately. While they were in this condition, their wives and friends, or children, came, took them home, and put them to sleep in their houses, where they continued sleeping till noon the next day, and some even till the evening of the following day. Any one of this people who does not take part in these drinking-bouts is considered a man unfit for war.

"While they were weeping and shouting at the feast, it was a fearful thing to see their mad capers, and while they were getting more and more drunk we became still more apprehensive, not knowing what the end of the feast would be and that we might be exposed to great danger. The women, the wives of the most distinguished men, act in the same way by themselves. Once indeed we thought that the dance and the drunkenness were becoming dangerous to us, the six or seven Spaniards who were present, and therefore we were on the lookout, and with arms ready, for, although we were not numerous enough to defend ourselves against such odds, still we were determined to sell our lives very dearly, and to try to kill the cacique and as many as possible of the leading men, without whom the lower people amount to but little, being quite lost and cowardly without their leaders. When the revelry was over, I said to the cacique that since he was a Christian, and also claimed that his best men and a great part of his people were Christians, they ought not to have started this drunken bout, because a man who is dead-drunk is nothing but a dirty brute. I also reminded him of the fact he already knew, that man's best possession is reason and understanding, and that, the clearer his understanding, the greater is his advantage over other men, the more he is esteemed by others, and deserves their respect; but the more foolish, doltish, or ignorant he is, the more he resembles the beasts. I further reminded him that Christians must not do what he did, who most nights slept with a virgin, which was a great sin and abomination in the sight of the Lord, nor was it right for him to have more than one wife, and he had many, besides those virgins, whom he deflowered. He replied that he saw an evil in the drunken revelries, but that they were a custom inherited from his ancestors, and that, if he did not observe them, his people would not like it, but would consider him churlish and his conduct bad, and would leave the country. As regards the women, he said, that he would not have more than one, if it were possible, and that he thought he would be more contented with one, than with many, but that their parents gave the virgins to him and requested that he should take

them, and still others he took because they pleased him and in order to leave many children. As to deflowering the virgins, he said, that he simply did it in order to do a favor to them and their parents, for immediately the other Indians were more willing to marry them. To all this I replied, what seemed best to me, giving him to understand his error, and how all this was a very grave sin, and it was not the work of a Christian, but of an unbeliever, and he accepted what I told him and said that I gave him good advice and that he would improve little by little. But in fact his name corresponded to his works and his works to his name Nambi, which, as I have said, signifies '*dog.*'"

The above brief extracts contain in the main almost all the meager ethnological information regarding the early inhabitants of Nicoya, which the first historians of these parts of Costa Rica have furnished us.

As the few aborigines of pure, or almost pure, Indian blood, who still survive on the peninsula and near the pueblos of Nicoya and Matamboro have been almost completely absorbed by the mixed Spanish population, and have lost nearly all their primitive customs and ideas, even their language, the student of their history is now limited almost exclusively to the study of the objects hidden in the burial-grounds and mounds.

The language has long since been practically extinct in these parts. During my sojourn on the peninsula in 1897 I obtained, however, from one of the older Indians in the pueblo of Nicoya by the name of Martin Luz, then a man apparently about sixty years old, a few words of salutation, the only ones he could recall. His grand-parents, who died at a very old age had still spoken the language when he was a young boy, and he informed me that a priest in the pueblo, whose name he could not remember, had made a vocabulary of the idiom. The native words noted down with the translations, as understood and given me by this Indian were: "Ká-pe-manche," *buenos dias*, which salutation always was answered with the expression "Ká-pe-hue-jo," "Su-su-mú-rio," *como estámos?* "Ni-mun-gís pa-ní-ki," *como esta la familia?* "Sió," *Adios!* Other words and expressions can probably still be had from old Indians in these parts, but time never allowed me to make further inquiries in regard to the matter.

II. Previous Investigations on the Peninsula of Nicoya.

The first archeological material from the peninsula of Nicoya, procured by any scientific institution, consisted of a number of objects, which were included in the general Costa Rican collection of antiquities, consisting of about one thousand specimens, which by purchases from natives was brought together by the German Consul

in San José, Johann Friedrich Lahmann, and which in the year 1862 was sold to the Museum of Natural History in Bremen for the sum of ten thousand marks. Two publications founded upon part of this material have seen the light, one by Dr. Strebel,[1] the other by Professor Fischer.[2] The former work only describes the ceramic material from the territory of the Güetares. The latter is devoted to a study and description of all the small sculptured objects of stone, amulets, beads, tubes, etc., comprising sixty-three specimens. Most of these objects are from localities on the mainland adjoining the peninsula of Nicoya. Some eighteen specimens, however, were obtained from the province of Santa Cruz in Nicoya. There are five plates with forty-nine figures, all of which resemble objects of the typical "Las Guacas" culture.

In the year 1865 Professor Carl von Seebach visited Guanacaste and mentions the occurrence of Indian graves, but he undertook no excavations.

The first archeologist, who made any investigations in Nicoya, was the explorer of Nicaragua, Dr. J. F. Bransford, who in the year 1877, accompanied by Dr. Earl Flint, entered the peninsula from the Nicaraguan frontier, and made an exploring trip as far south as the pueblo of Nicoya. Pages 73–79 in his work "Archeological Researches in Nicaragua," are devoted to a description of his observations. He mentions the presence of stone- and shell-heaps in various localities and the discovery of ancient relics, but his investigations in Costa Rica were in no place as extensive or detailed as in Nicaragua. His relation of excavations near the pueblo of Nicoya are here quoted in full: "At the town of Nicoya a turtle-shaped whistle and two small vessels were obtained, and a little further south in the valleys among the mountains were observed many mounds and other remains of antiquity. The mounds were usually about five feet in height and forty in diameter at the base. In the road-cuts and gullies fragments of stone implements and terra-cotta were abundant. A piece of a fine long celt of tremolite was lying in the rut, broken by a cart wheel. We purchased two whistles and some little vessels in this neighborhood, and were shown the locality where they had been discovered with human bones and several metates. I employed four men at work there for half a day, and unearthed three whistles, four small vessels, and bones of several skeletons. Each body appeared to have been interred with a small earthen vessel and a whistle. This place, about a mile and a half southeast of the town, where the crest of the ridge was crossed by the road, was called Punta de Monte. The specimens were lying in red clay on a yellowish trap

[1] Strebel, Hermann. "Bericht über die Sammlung Alterthümer aus Costa Rica in Bremer Museum." — *Abh. v. Naturw. Verein zu Bremen*, VIII., 1883, p. 233–253.

[2] Fischer, H. "Bericht über eine Anzahl Steinsculpturen aus Costa Rica." — *Abh. v. Naturw. Verein zu Bremen*, VII, 1881, p. 152–175.

or cascajo, about four feet below the surface, and had been exposed in a cut in the road by the wash of the rainy season."

Of the objects Dr. Bransford obtained on the peninsula he has figured the two whistles mentioned in the text and on a plate sixteen objects in green stone. All these specimens resemble common types of Las Guacas. His collection is preserved in the United States National Museum in Washington.

In a publication of 1894 Sr. Don Anastasio Alfaro[3] describes a tour of reconnaissance he made in a former year to the province of Guanacaste and mentions the existence of large shell-heaps, as well as other ancient remains. In conclusion he states: "In the whole of this province of Guanacaste it is a very difficult undertaking to excavate any ancient grave, for the reason that the ground is very hard and because the relics are first encountered at the depth of two to three meters and in the greatest confusion. And, as it further is not possible to know where the objects are placed, being mixed up with earth, stones, and potsherds, which the Indians used for filling up the graves, most of them upon excavation are broken to pieces."

In the year 1888 the National Museum of Costa Rica purchased for two thousand pesos a collection of 600 archeological objects brought together from various parts of the peninsula, but principally from the neighborhood of the pueblo of Nicoya, by Juan J. Matarrita, a native official who accompanied Dr. Bransford on his journey.[4]

In the following year the same institution procured the Fornera and Abruzzo Collection of some two hundred specimens from Nicoya and in the year 1894 was added a second Velasco collection of about twenty-seven hundred objects.

In 1895 Mr. Åke Sjögren, then a resident civil engineer on the Pacific coast of Costa Rica, made a journey throughout the peninsula in order to investigate mineralogical features and especially to ascertain the source of the ancient supply of jade. He carried on excavations at Indian sites in various parts, and also made a sojourn at Las Guacas, while the work of Velasco's men was there in progress. Reference to his observations are given by Thomas Wilson[5] of the United States National Museum.

In 1897 from March to September the writer carried on excavations with six to twelve men at various burial-grounds and other ancient sites on the peninsula of Nicoya, on Chira and other islands of the Gulf as well as on the mainland near Puntarenas. The results of this work, now preserved in the Stockholm Ethnographical Museum are as yet not published.

In the year 1899 Dr. Carl Sapper entered the peninsula from Nicaragua and

[3] Alfaro, Anastasio. "Antigüedádes de Costa Rica," San José, Costa Rica, 1896, p. 14, 15.

[4] Ferraz, Juan F. "Informe de Museo Nacional de Costa Rica," 1897–1898.

[5] Wilson, Thomas. "Prehistoric Art," Annual Report U. S. National Museum, 1896, pp. 458–459.

also made a visit to Las Guacas. In a valuable paper[6] he gives an account of his archeological observations on the peninsula, briefly describing this burial-ground and its artefacts, and making comparisons with ancient remains observed by him in other parts of Central America.

III. Las Guacas Near the Pueblo of Nicoya.

The rugged forest-covered mountain-chains of the southwestern part of the peninsula of Nicoya reach a height of about six to eight hundred meters and some isolated mountain peaks rise to one thousand meters and more. About four leagues southeast of the pueblo of Nicoya, or, on account of the steep and difficult approach, half a day's ride from that place, there is on a high mountain-ridge, uniting the Cordillera de Santa Rita and the Cordillera de Canillas, a canyon and a mountain-pass named *La Quebrada de Las Guacas* on account of the ancient remains or "guacas" there found. The present settlement near the "guacas" is simply known under the name *Las Guacas*. According to information I obtained from the people now living at the spot and from old persons in the pueblo of Nicoya, professional hunters from the latter place used of old to make yearly excursions to Las Guacas where they had small "ranchos para cazar." A narrow trail was thus kept open to this spot through the forests and thickets of the mountain-slope. No one of the present inhabitants of Nicoya, however, recollects the time when Indians occupied this spot, or know about any earlier Spanish occcupation of the place. According to the same informants it was about the year 1877 that two natives of Nicoya, Silvestre Rodriguez and one Villalobo began to clear the forest and first broke the ground for cultivation. Some years later the present owner, Antonio Carillo, a mulatto, purchased the right to the place. He built houses for himself and relatives, who now have cleared an extensive portion of the territory for the cultivation of sugar-cane, corn, beans, and other crops. From the green fields a fine view opens over the Gulf of Nicoya with its islands, and from the opposite side of the peninsula, the "tumbos," the thunderings of the high waves of the great ocean, are plainly heard when the wind blows from that side. In the neighborhood of Las Guacas are the headwaters of the Rio Zapotal and the Rio Tabacco, which empty their waters directly into the ocean, and Rio Blanco and Rio Camarron, which have their outflow into the Gulf of Nicoya. Heavy primeval forests surround the little settlement on all sides. These forest-covered mountain-chains are very rich in game of many species. They teem with deer, wild hogs, tapirs, jaguars, tepezcuíntle, (*Cœlogenys paca* (Linnæus)) and other animals.

[6] Sapper, Carl. "Huacas der Halb-Insel Nicoya," *Zeitschrift für Ethnologie*, 1899, Heft VI, pp. 622–632.

It was while breaking ground here that the pioneer settlers discovered the ancient burial-ground, which afterwards made the place famous in these parts. In the beginning little attention was paid to the burials. Only occasionally, when a metate was needed for some house, digging was resorted to in order to obtain one of the ancient stones. However, after the discovery of a golden ornament in the burial-ground interest was aroused, and Padre José Maria Velasco, who then lived in Nicoya, entered as a partner with Antonio Carillo in the work of excavating on a larger scale. Padre Velasco's interest for the antiquities of the peninsula had been aroused by the late Bishop B. Thiel, who on his journeys and visits always procured material for the collection he formed and afterwards devised to the Catholic Seminary in San José.

After the first collection made by Velasco had been placed in the museum in San José, the excavations were resumed by Velasco on a still larger scale, and a collection of about twenty-six hundred specimens was made and shipped to the Atlanta Cotton Exposition. This collection was afterwards deposited in the Commercial Museum in Philadelphia, and by the Director, Dr. W. P. Wilson, loaned to the Free Museum of Science and Art of the University of Pennsylvania, where it still was at the time of its purchase by the Carnegie Museum.

On my first visit to Nicoya in the year 1896 I desired to make arrangements with Velasco for securing permission to excavate at Las Guacas, but at that time no satisfactory agreement could be made. I visited the burial-ground, however, and carried on excavations at various ancient sites in the neighborhood.

Upon my return to Costa Rica for the Carnegie Museum I first of all secured from Velasco the collection, deposited in Philadelphia,[7] and also another collection

[7] As to the importance of this collection from an archeological standpoint, I am happy to quote the following authorities:

Professor Frank Hamilton Cushing wrote before the collection had been acquired by the Carnegie Museum "This collection is intrinsically valuable, consisting as it does of jade, jadeite, fine terra-cotta, shell, and gold . . . There is no single collection of aboriginal American art works in stone, in any museum here, or, so far as I am informed, abroad, that can compare with this one as to the number of examples it contains of superbly carved, polished, and finished specimens, that are at the same time of the highest artistic beauty, even from our standpoint. So true is this, that I venture to say that no lapidary would undertake to duplicate the stone series alone for less than four times the price that is charged for this entire treasury of ancient American gems. . . .

"But above all the collection is unique among American collections of its kind, thus far gathered, in scientific importance of a very definite sort. It abounds in types illustrating not only the origin of many forms of weapon, symbol, and decoration, but also of the part myth and religious concept play in the modification conventionally, of all these things."

"Were I a man of large means, I would unhesitatingly buy the collection, if only for the sake of having it to study and publish, illustrated, to the world . . ."

Professor Max Uhle wrote: "I examined the Velasco Collection of Costa Rican antiquities with lively pleasure, as I consider it a most important basis for a representative collection of Central American antiquities . . . This collec-

made subsequently, being his fourth collection from Las Guacas, to which was added an extensive collection of pottery, belonging to him, gathered from various localities in the neighborhood of the pueblo of Nicoya, altogether two thousand one hundred and seventy-two specimens.

This transfer having been accomplished and some time having been devoted to a study of the collections from the Pacific Coast in the National Museum in San José, I proceeded to investigate the burial-ground of Las Guacas. It was high time to do some systematic work, if even on only a small scale, at this important place, which had yielded such rich treasures, before the very last corner of the territory had been exhausted. This work was carried on with a force of twelve men for about four weeks until the rains stopped us. The objects obtained during the excavations of Velasco and myself furnish a representative series of the art products in clay, stone, and metal, which are typical of the culture which apparently predominated in the whole region even to the islands of the gulf. The discovery I made of other methods of burial and artefacts of different characters in certain other localities of the peninsula will receive due attention in later papers.

IV. Excavations at Las Guacas.

(See Map, Plate XLVII.)

The site of the burial-ground is almost level and was entirely covered with forest-growth when Carillo settled at this place. There were no indications above the ground of the treasures hidden below. The numerous pieces of broken pottery and the metates met with close to the surface proved nothing, as similar accumulations are common enough in these regions near ancient settlements and do not necessarily indicate burials. The entire burial-ground does not seem to include more than a few acres, but is described as varying much in depth, containing, especially in the central part, several burials one above the other. Close to the road leading up to Carillo's house a corner was left, which had never before been touched and here my work was begun.

tion is of extraordinary importance. It comes from a province of Central America most important from a historical point of view. It seems to me, with my knowledge of the richest European and other museums, to be unique in its wonderful implements of stone and according to my modest experience, as far as objects of jade and nephrite are concerned, unequalled by any collection in the world. We shall have to inquire more closely into the relations once existing between the tribes of Central and South America in the near future and it would be difficult to find another collection as appropriate as this on which to base the investigation of the connecting links."

Professor D. G. Brinton wrote: "No other collection of jade and other implements and utensils from Costa Rica equalling Velasco's has been made from that area. It is well located and very typical of the culture of the natives from whose territory it comes. The abundance in it of jade or nephrite objects is remarkable, and renders it unique and valuable for this alone. Probably no equally fine line of specimens from those tribes will again be offered. Both from the ethnographic and artistic point of view, it has exceptional merit."

Excavations, started at the spot selected, showed a surface layer of black humus about half a meter thick, which contained numerous pieces of red and black pot-sherds. Below the humus a layer of red clay was met. This layer had a thickness of from one to one and a half meters, and in parts contained lumps of humus, and rested upon a bottom layer of yellowish-white conglomerate of rather hard consistency, called by the natives *cascajo*. In this substratum, which was perfectly dry, the Indians had hollowed out pits or cavities, more or less oval or circular, and in these they had placed the bodies of the dead with their vessels, metates, ornaments, etc. The pits had then been refilled with the same material and it was alone through its looser consistency that I was enabled, although with great difficulty, to determine to a certain extent the location and form of graves. The task would have been still more difficult without the previous knowledge of the burial-pits of this region, which I had obtained during my excavations in 1897. I had at that time an opportunity to examine a number of similar graves at Las Casitas, near the pueblo of Nicoya, where the conglomerate formed a high naked hill, not covered by any layer of soil or clay, and had become almost as hard as rock by exposure to the air. This was also the case on a hill at Las Guacas, adjoining the burial ground, where, however, no burial-pits were found.[8] At Las Casitas the flat top of the hill was in one spot almost honey-combed with pits close to each other. These cavities were in most cases well preserved and their form could be well determined. Figs. 1 and 2 show vertical and horizontal sections of one of the typical pits at Las

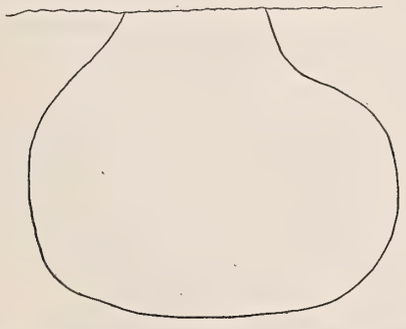


FIG. 1. Vertical Section of grave at Las Casitas.

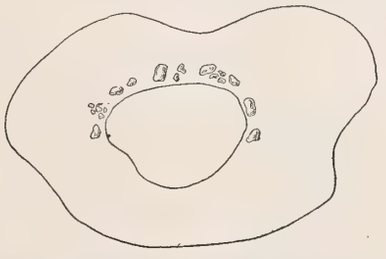


FIG. 2. Horizontal section of grave at Las Casitas, with portion of the circle of stones around the opening.

Casitas. A number of these pits with their contents were examined and records made during my sojourn at Las Casitas, but the latter have not as yet been published. The material is now preserved at Stockholm. As a rule the pits at Las Guacas were smaller and in places closer together. At the eastern end of the field

[8] In Dr. Sapper's description of the burial-ground, referred to above, no mention is made of the underground pits, but, probably at the time of his visit no traces of the outlines of the pits existed, and closer observations apparently were made impossible by the fact that Dr. Sapper during his comparatively short stay here was hindered in carrying on excavations of his own. Velasco's force was then at work excavating the burial-ground.

excavated at Las Guacas the soil was looser throughout, and here it was impossible to distinguish the outlines of the cavities.

Before starting the work here recorded we first had to dig through a piece of ground on the western side, which had been previously partly excavated in a superficial way. Here we met with a number of broken metates, some potsherds and other fragments. Only after we had struck parts where the soil had not recently been disturbed did our task of recording the finds seriously begin.

The detailed results of the excavations carried out are given in the following pages.

Burial No. I.

(See Map, Plate XLVII.)

At the depth of one and one half meter three semicircular pits were found, arranged triangularly and joining in a common center as shown on the plan. In these pits were deposited close to the bottom the now almost entirely decayed bones of five skeletons. The bones were placed in heaps close to the skulls, showing here, as in every other part of the cemetery, the prevalence of the method of bunched burials. In two cases metates (*b* and *d*) had each been placed immediately above a skull, thus protecting them from the pressure of the soil. The following artefacts were met with in this burial:

a. (*Pl. III, Fig. 3.*) Metate of grayish basaltic lava, plain, nearly rectangular in shape, three-legged, with slightly curved body, which shows signs of considerable wear. Legs cylindrical. Length 45 cm., breadth 33 cm., height at the middle of plate 13 cm., thickness of the plate about 3 cm. Found standing leaning to the right near the south wall, 1.95 m. below the surface.

FIG. 3. Small Figurine. (Cat. No. $\frac{2793}{2}$.) $\frac{1}{2}$.

b. Rectangular plain metate, almost flat, with three short cylindrical legs. Resembles *a*. Shows signs of wear. Length 42cm., breadth about 28 cm., height about 5 cm., thickness of plate about 1 cm. Found standing close to the last (*a*) at 2.1 m. below the surface. (Cat. No. $\frac{2793}{2}$.)

c. (*Fig. 3.*) Small human figurine of clay in sitting position. Color reddish yellow. The breasts and arms adorned with designs in black. The head-dress painted red. Sex not marked. The body is hollow, broken. Height 10.5 cm., breadth at the elbows 7 cm. Found lying on the top of metate *b*. Figurines of this type are of rather common occurrence in this burial-ground.

d. (*Pl. IV, Figs. 1, 2, and Pl. V, Fig. 1.*) Unusually large, rectangular metate

of most excellent workmanship, with very high, slender, cylindrical legs, and a thin plate. This specimen is richly ornamented with sculptured designs. On the upper side each end shows a band 5 cm. broad, with a small bird-design in the middle, the head extending from the edge, and guilloche patterns on the sides. The whole lower side of the body is nearly covered with designs, mostly geometrical, consisting of guilloche and meander patterns. A meander band divides its surface into two fields of which the larger is partly filled with a highly conventionalized bird-design, the smaller contains a conventionalized human (?) head on a long neck. The lower ends of the legs are adorned with geometrical designs. Length about 62 cm., breadth about 36 cm., height about 23 cm., thickness of the plate about 1.5 cm. Found standing leaning to the left at a depth of 2 m. below the surface.

Burial II.

This was a small pit, oval in section, about one meter in diameter. Contained at the depth of about 1.5 m. near the north side one bunched burial. Standing almost upright close to this we found:

a. (*Pl. III, Fig. 4.*) Metate of nearly oval shape, slightly concave and with three short, nearly knoblike legs. Length 49 cm., breadth about 30 cm., height 9 cm. Lying on the top of this were found four beads of greenstone:

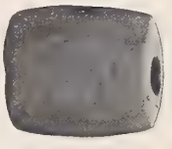


FIG. 4. Bead of pale green bowenite. (Cat. No. $\frac{2793}{6}$.) $\frac{1}{1}$.

b. (*Fig. 4.*) Bead of pale green bowenite, flattened cylindrical. Length 2 cm., breadth 1.8 cm., thickness 0.7 cm.

c. Bead of pale green bowenite, flattened cylindrical, resembling *b*. Measurements the same as of the above. (Cat. No. $\frac{2793}{7}$.)

d. (*Fig. 5.*) Bead of pale green bowenite, cylindrical. Length 2.5 cm., diameter 0.5 cm.

e. Bead of dark green saussurite, cylindrical, resembling *d*. Length 2.4 cm. Diameter 0.7 cm. (Cat. No $\frac{2793}{9}$.)

Burial III.

Circular pit with a diameter of about one meter. On the north side, and at the depth of 2–2.5 meters, were the remains of two skeletons. No object was found deposited with them, but a few small potsherds were scattered in the soil.

FIG. 5. Bead of pale green bowenite. (Cat. No. $\frac{2793}{8}$.) $\frac{1}{1}$.

Burial IV.

Pit nearly oval. Largest diameter 1.1 m. Contained at the depth of about 2 m. and close to the east side a bunched burial. Here was found a rectangular, three-legged metate, resembling in general shape the specimen given on Pl. VI, Fig. 1. The upper side was plain,

the under side surrounded with a broad band with guilloche designs. The cylindrical legs are adorned with rings in relief near the base. Length 54 cm., breadth at the middle 32 cm., height 9 cm. Broken in two parts. Found standing on the west side of the skeleton about 2.2 m. below the surface. (Cat. No. $\frac{2793}{10}$).

Burial V.

Almost circular pit about 1 cm. in diameter, containing two bunched burials, one at the depth of about 2 m., the other at the depth of 2.4 m. No other object was met.

Burial VI.

Oval pit, greatest length 0.8 m., containing two bunched burials, one at the eastern end at the depth of about 1.8 m., the other at the western end and at the depth of 2.2 m. Here was found a metate (Pl. VII, Fig. 2), plain, with three high, almost square, somewhat curved legs, tapering toward the ends. Length about 44 cm., breadth about 26 cm., height 16 cm. It was discovered between the two skeletons and lying on its side with the legs toward the west.

Burial VII.

Pit, oblong in section. Length about 1 m. It contained at the eastern end one bunched burial at the depth of about 2 m. In this grave there were also found, at the depth of about 1.5 m.

a. Small piece of slate. Length 5 cm. (Cat. No. $\frac{2793}{12}$.)

b. Cylindrical leg of a small metate. (Lost.)

c. Fragments of pottery. (Not preserved.)

Burial VIII.

This consisted of three circular pits combined, forming an oblong figure about 1.75 m. in length and 1 m. in breadth. At the southern end were found two bunched burials at about 2 m. depth, at the northern end one bunched burial at 1.5 m.

a. (Pl. VI, Fig. 1, 2.) Metate, large, rectangular, with high cylindrical legs. On the upper side the borders of each end are adorned with a sculptured band of guilloche designs 8 cm. broad. The under side is enframed by a band 9 cm. broad with similar designs. (See Pl. VII, Fig. 1.) Legs cylindrical, high, with geometrical designs. Length about 60 cm., breadth about 45 cm., height 20 cm. Found standing 2.1 m. below the surface near the northern side of the grave, close to the skeletons.

On the top of this metate there were found two amulets of stone.

b. (Figs. 6, 7, 8.) Amulet of green polished bowenite, made in the shape of a small flat ax, the upper part showing the head and breast of a human figure with crossed arms and head-dress sculptured in low relief, the lower part flat, without

sculptures. At the neck there is a transverse, cylindrical perforation for suspension. This amulet has been damaged by fire, as is shown on the back. Length 8.1 cm., breadth 2.5 cm.

c. (Figs. 9, 10, 11.) Amulet long, rectangular, of grayish polished stone. The upper half shows a human head and breast, with crossed arms. The lower half

FIG. 6. Front view of amulet of green bowenite. (Cat. No. $\frac{27933}{14}$.) $\frac{1}{2}$.

FIG. 7. Back view of amulet. (Cat. No. $\frac{27933}{14}$.) $\frac{1}{2}$.

FIG. 8. Side view of amulet. (Cat. No. $\frac{27933}{14}$.) $\frac{1}{2}$.

is flat, plain. There is a transverse, cylindrical perforation at the neck. Length 13 cm., breadth 3.4 cm.

d. (Pl. VIII, Figs. 1, 2.) Rectangular metate, with three cylindrical legs. Upper side plain, but the entire under side covered with designs. Inside of the frame the whole surface is occupied by the figure of a bird with spread wings and broad tail. The head of the bird is sculptured on the single leg, the feet on the paired legs of

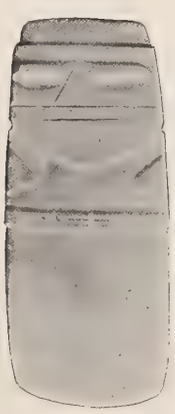


FIG. 9. Front view of grayish stone amulet. (Cat. No. $\frac{27933}{15}$.) $\frac{1}{2}$.

FIG. 10. Back view. (Cat. No. $\frac{27933}{15}$.) $\frac{1}{2}$.

FIG. 11. Side view. (Cat. No. $\frac{27933}{15}$.) $\frac{1}{2}$.

the metate. The decoration at each end consists of a narrow band with two opposing animal heads joined together by a guilloche design, representing the body. The legs of the metate are each encircled with three raised, parallel bands around

the lower ends. Length 55 cm., breadth 37.5 cm., height 14 cm. Found standing 2.2 m. below the surface at the eastern end of the grave.

e. Plain metate with three cylindrical legs. Resembles Pl. I, Fig. 3. Length 42 cm., breadth 27 cm., height 10 cm. Found standing 2.4 m. below the surface, near the southern end and close to the two skeletons.

FIG. 12. Pestle of clay. (Cat. No. $\frac{2793}{18}$.) $\frac{1}{2}$.

FIG. 13. Figurine. (Cat. No. $\frac{2793}{19}$.) $\frac{1}{2}$.

f. (Fig. 12.) Pestle of red clay with an animal head at the top. Length 11.5 cm., diameter at the base 4.5 cm. Found 1.8 m. below the surface close to the burial at the northern end.

Close to this object and at the same depth there was found:

g. (Fig. 13.) A small human figure with large grotesque head, sitting on a small, rectangular, four-legged seat and holding a child on its knees. The figure wears a hat with linear, incised ornamentation. Height of figure 8 cm. The seat is adorned with a protruding animal head at each end. Length 11 cm., height 2.5 cm.

Burial IX.

Pit nearly circular, diameter about 1 m., containing one bunched burial close to the southern wall at the depth of about 1.8 m. Close to the skeleton in the middle of the pit there was found lying on its back:

a. A rectangular metate, plain, with three short, cylindrical legs. Resembles Pl. III, Fig. 3. Length 45 cm., breadth 30 cm., height 8 cm. Left at Las Guacas Near this metate, on the northern side, we found the following smaller artefacts:

b. (Fig. 14.) Ocarina, or whistle of clay, painted black, with the head of a bat in relief at the base of the mouth-piece. Through impressions with some tool (roulette?) the surface of the back has been covered with a pitted ornamentation.

A plain band around the center divides this peculiar ornamentation into two zones. Air-holes four. Length 9 cm., diameter 5.5 cm.

c. (Figs. 15, 16, 17.) Amulet in the shape of a thin, flat celt of polished gray serpentine. Upper half of the front adorned with a conventionalized human head with a large parted tongue (?) extending from below the mouth. The ridge on the

FIG. 14. Clay whistle. (Cat. No. $\frac{2793}{21}$.) $\frac{1}{2}$.

FIG. 15. Front view of amulet. (Cat. No. $\frac{2793}{22}$.) $\frac{1}{2}$.

FIG. 16. Back view of amulet. (Cat. No. $\frac{2793}{22}$.) $\frac{1}{2}$.

FIG. 17. Side view of amulet. (Cat. No. $\frac{2793}{22}$.) $\frac{1}{2}$.

back, left when removing this piece from the core, is plainly seen. Length 9.5 cm., diameter about 4 cm.

d. Oblong polishing stone of translucent agate. Length 3.5 cm., breadth 2.9 cm. Found close to the last object. (Cat. No. $\frac{2793}{23}$.)

Burial X.

Large oblong pit about 1.5 m. in breadth. Filled with a layer of bones almost half a meter thick, principally consisting of long bones of numerous individuals, but only a few skulls, all in fragmentary condition. No object was deposited with these remains.

Burial XI.

Nearly circular pit, about one meter in diameter, containing in the center one bunched burial at the depth of two meters. On the top of this was placed in standing position :

a. (Pl. IX, Figs. 1–4.) Metate of rare shape, of fine grained basaltic lava. Legs triangular, flattened, with slit perforations. Specimen highly adorned with sculptured designs in low relief on both the upper and lower sides of the plate, on the edges, and the legs. On the upper side only the borders at each end are adorned. The broader decoration at the front end shows a rectangular field 10 cm. broad, with two highly conventionalized human figures opposite each other. The bodies have entirely disappeared and the two large rectangular heads are connected by only a slender link. The arms are extended, each figure having one at alternate corners, transformed into a meander. The two protruding knobs at the front form part of a design belonging to the under side. The sculptured band, about 2 cm. broad, at the back of the upper side, shows a simple, purely linear design. The edges are adorned with a continued scroll design. The three legs are sculptured all over. Every attempt to decipher these conventionalized designs, embodied in the legs, proved futile as long as I examined the object in its natural standing position. But when I turned it on its back the conception of the sculptor was soon revealed. Before I had thus discovered the meaning of the design, the purpose of the small circular holes of these legs was most puzzling. The large, oblong slits had undoubtedly served for securing the metate to the wall or some object in order to keep it steady during the grinding process. Besides there were at the front two special loops which might have served a similar purpose. The smaller, circular holes appeared consequently totally superfluous. While trying to designate some possible utilitarian reason for these holes, the anthropomorphic design revealed itself, and I now realized that the holes had been bored merely to indicate the openings between the arms and the body and below the knees of the human or simian figures which the legs represent.[9] (See Pl. IX, Fig. 4.)

FIG. 18. Oblong celt. (Cat. No. $\frac{2793}{25}$.) $\frac{1}{1}$.

Both loops, too, at the front of the specimen here described, as seen from the lower side, apparently represent a human or simian figure with the united arms bent toward the chin or mouth. In

[9] Compare also Pl. XV, Figs. 1–4, Pl. XVI, Figs. 1–4, and Pl. XVII, Figs. 1, 2, showing metates of the same peculiar type and from the same locality, all belonging to the Velasco collections. Pl. IX, Fig. 4, shows most plainly the whole simian figure in a sitting position, with both arms bent upward toward the mouth, the tail kept parallel with the back and joined to the neck. In Pl. XVII, Figs. 1, 2, the human traits are lost, and only through comparison and observation of forms like those above described can any understanding of the original conception of the sculptor be attained.

the ceramic art from the highlands this representation in more or less realistic form is of rather common occurrence. Compare Pl. 43, Fig. 9, Pl. 40, Fig. 2, and many others in my previous work, "Archæological Researches in Costa Rica." It is usually, if not in all cases, the representation of a flute-blowing individual. About the highly conventionalized design which adorns the surface of the under side, I am unable to venture any explanation, on account of the lack of material for comparison. This highly artistic metate plainly shows signs of wear. Length 38 cm., breadth 20 cm., height 14 cm., thickness of plate 2.5 cm.

b. (Fig. 18.) Oblong celt of blackish-green stone, highly polished, except at the upper end, which has been hafted. Section oval. Edge curved. Length 7.1 cm., breadth 3.9 cm. Found about 1 m. below the surface near the eastern side.

Burial XII.

Pit oblong in section. Length about 1 meter. Contained one bunched burial close to the northern wall at the depth of about 1.5 m. Near the western wall at the same depth were found:

a. Large metate having a flat surface and three square legs with corners rounded. It resembles Pl. III, Fig. 3. Broken. Length 52 cm., breadth 36 cm., height 12 cm.

FIG. 19. Polishing stone of agate. (Cat. No. $\frac{2793}{27}$.) $\frac{1}{1}$.

FIG. 20. Small Pot. (Cat. No. $\frac{2793}{28}$). $\frac{1}{2}$.

FIG. 21. Polishing stone. (Cat. No. $\frac{2793}{29}$.) $\frac{1}{1}$.

FIG. 22. Polishing stone. (Cat. No. $\frac{2793}{30}$.) $\frac{1}{1}$.

b. (Fig. 19.) Oblong polishing stone of agate. Length 3.5 cm., breadth 2.3 cm. Found close to the last object.

Burial XIII.

Pit oblong in section. Length 1.15 m. Containing one bunched burial close to the western wall and in one spot near the eastern end at the depth of about 1 m. were found:

a. (Fig. 20.) Small globular pot with narrow mouth and low rim. Color red. Height 5.5 cm., diameter 6 cm.

b. (Fig. 21.) Oblong polishing stone of agate. Length 3.8 cm., breadth 2.7 cm. Found close to the last object.

c. (Fig. 22.) Small polishing stone of agate, translucent. Length 2.5 cm., breadth 1.6 cm. Found together with the last.

d. (Figs. 23, 24.) Small narrow and thin celt-shaped amulet of serpentine, with

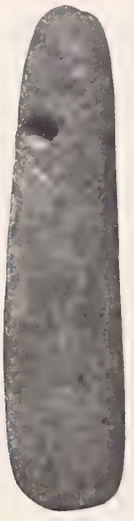


FIG. 23. Front view of serpentine amulet. (Cat. No. $\frac{2793}{31}$.) $\frac{1}{1}$.

FIG. 24. Side view of serpentine amulet.

a round hole for suspension. Color mottled greenish. Length 7 cm., breadth 1.7 cm., thickness 0.5 cm. Found together with the polishing stones.

Burial XIV.

Pit oblong in section. Length 1.25 m. In the center one bunched burial at the depth of about 1.2 m., but with no other objects.

Burial XV.

Oblong grave consisting of two pits joined. Combined length 2 m. At the eastern end we found one bunched burial at the depth of about 1.35 m., and close

FIG. 25. Bead. (Cat. No. $\frac{2793}{32}$.) $\frac{1}{2}$.

FIG. 26. Gypsum bead. (Cat. No. $\frac{2793}{33}$.) $\frac{1}{2}$.

FIG. 27. Saussurite bead. (Cat. No. $\frac{2793}{36}$.) $\frac{1}{2}$.

to the northern wall three others in one heap at the depth of about 2.3 m. Close to these we found five large oblong beads lying close together.

a. (Fig. 25.) Oblong massive bead of opaque white impure gypsum. Perforation cylindrical. Length 8 cm., diameter 3.5 cm.

b. (Fig. 26.) Tubular bead of opaque white gypsum tapering towards the ends Length 11 cm., diameter 2.5 cm.

c. Oblong massive bead of white gypsum. Length 5.5 cm., diameter 2 cm. (Cat. No. $\frac{27933}{34}$.)

d. Oblong massive bead of white gypsum resembling *a* in shape. Length 5 cm., diameter 2 cm. (Cat. No. $\frac{27933}{35}$.)

e. (Fig. 27.) Oblong massive bead of dark green saussurite. Length 6 cm., diameter 3 cm.

In the southeastern part of the grave, at a depth of about 1.5 m., we found:

f. (Fig. 28.) Diminutive depressed globular narrow-mouthed pot, representing a bird. The eyes, beak, wings, and tail in relief. Ornamented with a simple angular incised band on both sides above the wings. Of yellowish color, partly blackened by burning. Height 4.6 cm., diameter 5.6 cm.

Burial XVI.

Oval pit about 1 m. in length. Contained at the eastern end one bunched burial, at a depth of about 1.9 m. At the western end, 1.8 m. below the surface, were found:

a. (Pl. III, Fig. 5.) Metate of nearly oval form, concave, and with three short knob-like legs. Color reddish. Length 40 cm., breadth 27 cm., height 10 cm. On the top of the metate were placed five small objects of green stone, namely:

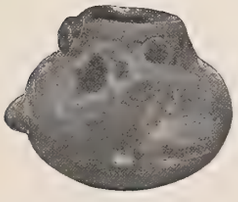


FIG. 28. Miniature pot. (Cat. $\frac{27933}{37}$.) $\frac{1}{2}$.

FIG. 29. Head of bird. (Cat. No. $\frac{27933}{39}$.) $\frac{1}{1}$.

FIG. 30. Head of bird. (Cat. No. $\frac{27933}{40}$.) $\frac{1}{1}$.

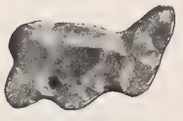


FIG. 31. Animal figure. (Cat. No. $\frac{27933}{41}$.) $\frac{1}{1}$.

b. (Fig. 29.) Bird-head of green bowenite, with long slender beak. Length of the object 2.5 cm.

c. (Fig. 30.) Bird-head of dark green bowenite. Length 3 cm.

d. (Fig. 31.) Small animal figure of mottled green saussurite with erect tail. Length 2.2 cm.

e. Cylindrical bead of green bowenite. Length 2.2 cm., diameter 1 cm. Resembles Fig. 5. (Cat. No. $\frac{27933}{42}$.)

f. Cylindrical bead of green bowenite. Length 2.4 cm., diameter 0.8 cm. Resembles Fig. 5. (Cat. No. $\frac{2793}{43}$.)

The objects, which were found in the adjoining pits, the forms of which could not be ascertained, are located on the map, Pl. XLVII, and described below.

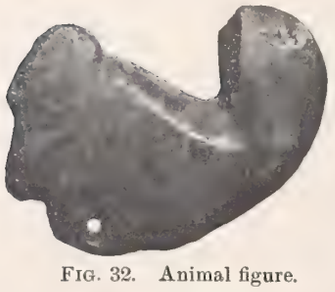


FIG. 32. Animal figure. (Cat. No. $\frac{2793}{47}$.) $\frac{1}{1}$.

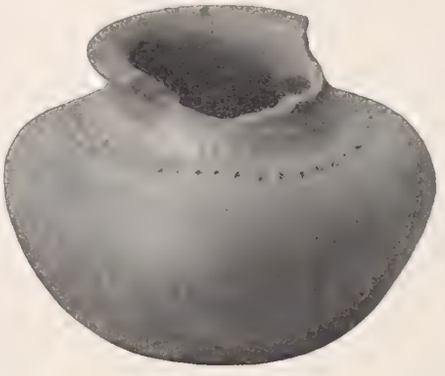


FIG. 33. Small pot. (Cat. No. $\frac{2793}{45}$.) $\frac{1}{2}$.

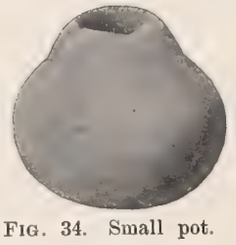


FIG. 34. Small pot. (Cat. No. $\frac{2793}{46}$.) $\frac{1}{2}$.

1. (Fig. 32.) Amulet of green saussurite in the shape of animal with tail erect. The animal is probably the ant-bear, which often is represented in the art of this region. The characteristic habit of this animal, which often walks with the tail standing nearly erect, has been emphasized by the artist. It may represent a skunk, or possibly a squirrel. Length 4.3 cm. Found at the depth of 1.2 m.

2. (Fig. 33.) Pot with nearly quadrangular contour as seen from above, rim curved, shoulder adorned with two concentric rows of incised dentations. Color red. Height 8.8 cm. Diameter 11 cm. Diameter of the mouth 6 cm. Found 1.5 m. below the surface.

3. (Fig. 34.) Small, nearly globular pot with narrow mouth. Color yellowish. Height 5.5 cm. Diameter 5.5 cm. Found at the depth of 1.6 m.

4. (Pl. III, Fig. 2.) Miniature metate, child's implement, rectangular, with three conical legs. Length 18 cm., breadth 14 cm., height 8.5 cm. Found on its side with legs toward the west.

5. "Curriol," a red mineral substance used for coloring pottery. Found immediately below the above metate.

6. (Pl. III, Fig. 1.) Small metate, child's implement, slightly curved plate, legs cylindrical. Length 28.5 cm., breadth 22.5 cm., height 10 cm. Found lying on its back 2.1 m. below the surface.

7. Metate resembling the last in shape and size. Length 18.5 cm., breadth 17.5 cm., height 7 cm. Found in the same position as the last and close to it. (Cat. No. $\frac{2793}{49}$.)

8. Globular pot with curved rim, at the base of which there is a pitted band decoration 0.5 cm. broad. Color red. Height 10.5 cm. Diameter 12 cm. Found standing on the last metate. (Cat. No. $\frac{2793}{50}$.)

9. (Fig. 35.) Ceremonial mace-head, perforated, of white polished gypsum, in the shape of what is probably the head of a bird. The pouch-like appendix below

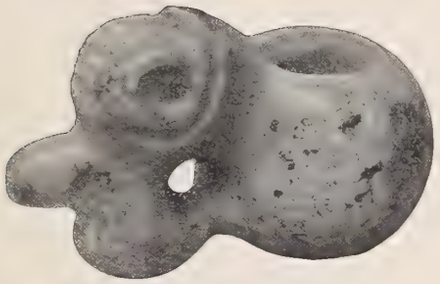


FIG. 35. Ceremonial mace-head. (Cat. No. $\frac{2793}{51}$.) $\frac{1}{2}$.

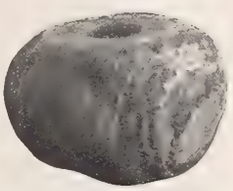


FIG. 36. Bead carved from cuttle-fish bone. (Cat. No. $\frac{2793}{52}$.) $\frac{2}{1}$.

FIG. 37. (Cat. No. $\frac{2793}{54}$.) $\frac{1}{2}$.

the throat may represent the wattled throat of the turkey. Length 11.3 cm., height 7.3 cm. Found close to the metates 1.9 m. below the surface.

10. (Fig. 36.) Small bead, round, carved from the bone of a cuttle-fish. Diameter 1.3 cm. Found close to the mace-head.

11. Bead similar to the above. Diameter 1.3 cm. Found close to the former. (Cat. No. $\frac{2793}{53}$.)

12. (Fig. 37.) Amulet consisting of a fine-grained, grayish celt, parted length-

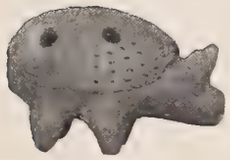


FIG. 38. Ocarina. (Cat. No. $\frac{2793}{55}$.) $\frac{1}{2}$.

FIG. 39. Whistle. (Cat. No. $\frac{2793}{56}$.) $\frac{1}{2}$.

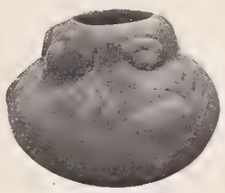


FIG. 40. Small Pot. (Cat. No. $\frac{2793}{57}$.) $\frac{1}{2}$.

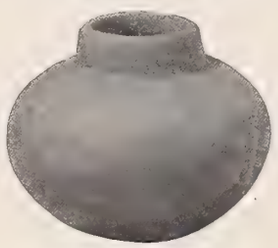


FIG. 41. Small Pot. (Cat. No. $\frac{2793}{59}$.) $\frac{1}{2}$.

wise and polished. Transverse perforation for suspension near the upper end. Length 10.5 cm., breadth at the lower end 4.8 cm.

13. (Fig. 38.) Small ocarina in the shape of an armadillo. Mouth-piece lost. Length 5.8 cm. Color red. Found 1.2 m. below the surface.

14. (Fig. 39.) Red clay whistle having the shape of a bird with broad flat beak, and spreading wings and tail. Height 6.7 cm., breadth 6.8 cm. Found at the depth of 1.35 m.

15. (Fig. 40.) Diminutive depressed globular pot, having the shape of a bird. Color yellow. Height 4.5 cm., diameter 6 cm. Found at the depth of 2.25 m.

16. Diminutive pot resembling the last. Height 4.6 cm., diameter 5.4 cm. Broken. Found close to the last. (Cat. No. $\frac{2793}{58}$.)

17. (Fig. 41.) Diminutive pot, depressed globular, with small orifice. Rim straight. Color red. Height 6.2 cm., diameter, 7.3 cm. Broken.

FIG. 42. Amulet. (Cat. No. $\frac{2793}{60}$.) $\frac{1}{2}$.

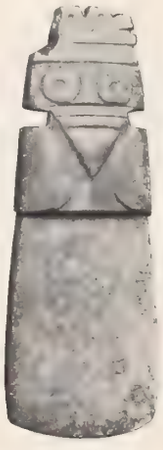


FIG. 43. Amulet. (Cat. No. $\frac{2793}{61}$.) $\frac{1}{2}$.

FIG. 44. Polishing stone. (Cat. No. $\frac{2793}{62}$.) $\frac{1}{1}$.

18. (Fig. 42.) Amulet of serpentine, oblong, thin, and flattened, representing a conventionalized human figure with head-dress, the lower half of the face sharply triangular. There are parallel incisions on each side of the abdomen to indicate the fingers. There are two circular holes at the upper end for suspension. Length 11.9 cm., breadth 3.3 cm.

19. (Fig. 43.) Ax-shaped amulet of polished green bowenite, rectangular. The upper half is gently convex, showing the head and wings of a bird (owl?) adorned with head ornaments composed of two opposing animal heads. The lower half below the wings is cut down to half the thickness of the upper half, and left plain. Length 11 cm., breadth 4 cm.

20. (Fig. 44.) Polishing stone, agate pebble, oblong. Length 4.2 cm., breadth 2.6 cm. Found at the depth of 1 m.

21. (Fig. 45.) Polishing stone, oblong pebble of opaque white agate. Length 3.3 cm., breadth 2 cm. Found close to the two former objects.

22. Polishing stone, agate pebble, translucent, oblong. Length 3.2 cm., breadth 1.6 cm. Found close to the last mentioned specimen. (Cat. No. $\frac{2793}{64}$.)

23. (Fig. 46.) Plain amulet of serpentine, nearly tongue-shaped, flat, thin, perforated with two round holes for suspension. Length 10.5 cm., breadth 3.8 cm. Found at the depth of 1.8 m.

FIG. 45. Polishing stone. (Cat. No. $\frac{2793}{63}$. $\frac{1}{1}$.)

FIG. 46. Amulet. (Cat. No. $\frac{2793}{65}$.) $\frac{1}{2}$.

FIG. 47. Amulet. (Cat. No. $\frac{2793}{66}$.) $\frac{1}{2}$.

24. (Fig. 47.) Celt-shaped amulet of dark green bowenite, representing a human figure with head-dress, the arms crossed on the breast. The eyes are represented by the two circular holes, which also serve for suspension. The nose is represented by a groove. The back is ground flat, showing no sign of the central ridge. Length 9 cm., breadth 2.3 cm. Found close to the above.

FIG. 48. Bead. (Cat. No. $\frac{2793}{67}$.) $\frac{1}{1}$.

25. (Fig. 48.) Cylindrical bead of gray stone. Length 1.3 cm. Found 1.25 m. below surface.

FIG. 49. Amulet. (Cat. No. $\frac{2793}{70}$.) $\frac{1}{2}$.

26. Celt of gray stone, small, polished, oval in section, edge curved somewhat obliquely. Resembles Pl. XXIII, Fig. 2. Length 7.3 cm. breadth 4 cm. Found at the depth of 1.2 m. (Cat. No. $\frac{2793}{68}$.)

27. Celt-shaped amulet of quartz with nearly parallel sides, the surface polish worn off. Length 8.5 cm., breadth about 2.5 cm. Found at the depth of 2 m. (Cat. No. $\frac{2793}{69}$.)

28. (Fig. 49.) Celt-shaped amulet of light-green bowenite, with a conventionalized head sculptured at the top. The nose, or beak, triangular. Length, 8.5 cm., breadth 2.3 cm. Found 2.25 m. below the surface.

29. Diminutive, depressed globular pot, with small orifice. Resembles Fig. 41. Color red. Height 4 cm. Diameter 6 cm. Found at the depth of 2 m. (Cat. No. $\frac{2793}{71}$.)

30. (Fig. 50.) Celt of greenstone, oblong, flattened, polished, oval in section, edge curved. Length 9.5 cm., breadth 3.8 cm. Found at the depth of 0.9 m.

31. Celt of blackish greenstone, oblong, flattened, polished, oval in section, edge slightly curved. Length 7.2 cm., breadth 3.7 cm. Resembles Fig. 37. Found at depth of 0.9 m. (Cat. No. $\frac{2793}{73}$.)

32. (Fig. 51.) Celt-shaped amulet of quartz, representing a conventionalized

Fig. 50. Celt. (Cat. No. $\frac{2793}{72}$). $\frac{1}{1}$.

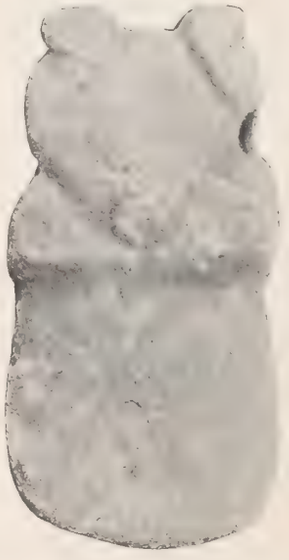


Fig. 51. Celt-like amulet. (Cat. No. $\frac{2793}{74}$.) $\frac{1}{1}$.

bird, eyes not marked. Lower half flat, thin. Length 6.7 cm., breadth 3.4 cm. Found close to the last.

33. (Fig. 52.) Celt-shaped amulet of whitish quartz, representing human figure. Head in this specimen narrower than the body. Length 6.4 cm., breadth 2 cm. Found close to the last.

34. Celt-shaped amulet of blackish-green, highly polished jade. Length 10.7 cm., breadth 4 cm. Resembles Pl. I, Fig. 18. Found 2.1 m. below the surface. (Cat. No. $\frac{2793}{76}$).

35. (Fig. 53.) Bark-scraper of greenstone, oval, flat. This is an instrument used for preparing bark for clothing and other purposes. The margin shows a groove running all round the object and serving for the fastening of the handle.

The side, which was used for the scraping process, is provided with seven parallel straight grooves, each ridge of which is also provided with another shallow groove.

FIG. 52. Celt-like amulet. (Cat. No. $\frac{27933}{75}$.) $\frac{1}{1}$.

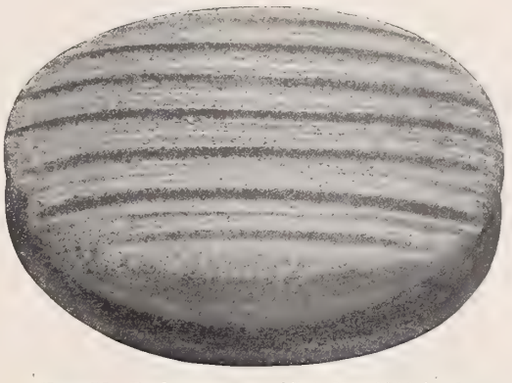


FIG. 53. Bark-scraper. (Cat. No. $\frac{27933}{77}$.) $\frac{1}{1}$.

The opposite side, used for smoothing, is flat. Length 7.3 cm., breadth 6 cm., thickness 2.8 cm. Found 1.35 m. below the surface.

This form has, as far as I have been able to ascertain, never been found on the Atlantic coast of Costa Rica, or in the highlands, but only in Nicoya. Similar bark-scrapers, but of nearly rectangular shape, I found in the year 1898 in various places on the Pacific coast of Salvador, in the present territory of the Pipiles. In Guatemala, in the city of Escuintla on the Pacific slope, I observed an ancient tool of the same general shape as the Costa Rican barkscraper, but entirely flat and smooth on both sides. It was of large size, probably weighing about two kilograms. It had been found years ago while making excavations for the foundations of a house. It was now used by the owner of a small hotel (Anderson's) for keeping the door open. The owner refused to part with it.

FIG. 54. Amulet. (Cat. No. $\frac{27933}{78}$.) $\frac{1}{2}$.

36. (Fig. 54.) Amulet, large parted celt of grayish stone, polished, and adorned with the representation of two very roughly sculptured, conventionalized human faces and arms. The nose in the upper face is indicated in a crude way by a vertical band with transverse, parallel, incised lines. The upper end is broken off. Length 13.2 cm., breadth 6 cm. Found 2.4 m. below the surface.

37. (Fig. 55.) Celt, large, symmetrical, smoothly polished, of mottled gray

greenstone, oval in section, edge curved. Length 13.2 cm., breadth 5.8 cm. Found at the depth of 0.9 m.

38. (Fig. 56.) Ceremonial club of white quartz in the shape of an owl's head with large orbits and ear-tufts. The nostrils are well indicated, but the eyes were omitted by the sculptor. Length 12 cm., breadth 8 cm. Found 2 m. below the surface.

After the work of excavating had been well started and the first burials laid bare for my own work with the trowel and tape-line, some of the men were put to work on an adjoining part of the burial-ground. The limited time and the difficulties caused by heavy rains only allowed me to record the finds from the small

FIG. 55. Celt. (Cat. No. $\frac{2793}{79}$.) $\frac{1}{2}$.

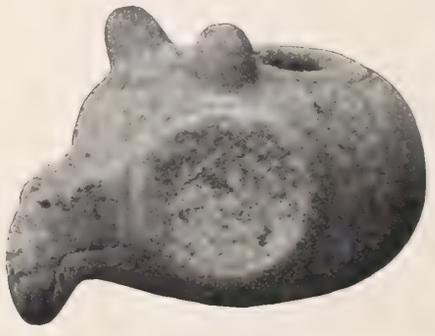


FIG. 56. Head of ceremonial club. (Cat. No. $\frac{2793}{80}$.) $\frac{1}{2}$.

portion of the burial-ground described above. Only partial attention could be paid to the excavations in the adjoining part. All the burials, however, here appeared to be of the same general character, but the burial-ground at this part being deeper, the fragments of the skeletons appeared in two layers of pits. In one spot not less than fourteen metates, turned upside down and most of them broken, were found almost in one heap in the greatest disorder and covering the fragments of several skeletons. The stone beads met with were only found singly or two to three together with a skeleton.

During my first visit to Las Guacas I had observed amongst the heaps of broken metates at the burial-ground several large flat blocks of sandstone, which were partly hollowed out, and on which celts probably had been polished. At my return, however, these stones had all disappeared. A number of the most characteristic objects unearthed on the above mentioned part of the burial-ground are described and figured below.

I. Objects of Stone.

1. (Pl. X, Figs. 1, 2.) Unusually large metate, with the upper side plain, the lower side covered with the sculptured design of a large bird (or vampire?) with outstretched wings and very small head with protruding eyes. The bird design is at each end limited by a broad band with meander designs. The high cylindrical legs are wholly covered with alternating annular and fluted ornamentation. Length 68 cm., breadth 27 cm., height 41 cm. (Cat. No. $\frac{2793}{81}$.)

2. (Pl. I, Fig. 10.) Large battle-ax of slate, double-bladed, sharp-edged. Length 22 cm., breadth of constricted part 6.3 cm. (Cat. No. $\frac{2793}{82}$.)

3. (Pl. I, Fig. 2.) Celt-shaped amulet of gray serpentine. The front side is convex. The upper half is occupied by a human head with large chin and adorned with a head-dress. The eyes are formed by small oblong grooves at each edge, the nose is rectangular, the mouth is adorned with a large plate-like lip-ornament extending to the apex of the chin. The arms or hands are indicated in a rudimentary way by a horizontal groove on each side of the abdomen. The lower half is plain. The central ridge on the back is retained. Transverse hole for suspension at the height of the mouth. Length 11.8 cm., breadth 4.8 cm. (Cat. No. $\frac{2793}{83}$.)

4. (Pl. I, Fig. 1.) Celt-shaped amulet of blackish-gray stone, highly polished. Upper side convex, showing a human head with head-dress, and the arms meeting on the abdomen. Below the mouth there is a triangular extension representing the tongue or a lip-ornament. The central ridge on the back is retained. Length 10.2 cm., breadth 4.8 cm. (Cat. No. $\frac{2793}{84}$.)

5. (Pl. I, Fig. 8.) Celt-shaped, flat amulet of light-green bowenite. The upper half shows a human face, crudely executed, represented by an incised rectangular frame inclosing two round pits, the eyes, which are united by a transverse groove. There is also a head-band with criss-cross design. The arms placed over the abdomen are indicated by two parallel incised lines. The central ridge has been removed through rubbing. Length 11.7 cm., breadth 5.4 cm. (Cat. No. $\frac{2793}{85}$.)

6. (Pl. I, Fig. 7.) Celt-shaped, rectangular, narrow amulet of mottled green serpentine. At the upper end there is a representation of a highly conventionalized human face, only the head-band and the nose, or chin, being indicated. Below the face there are two small round holes pierced for suspension. Back smooth and flat. Length 7.8 cm., breadth 1.6 cm. (Cat. No. $\frac{2793}{86}$.)

7. (Pl. I, Fig. 5.) Celt-shaped, nearly rectangular, narrow amulet of polished pale-green bowenite. At the upper end below the circular suspension hole there is a transverse groove, and below this two parallel, incised lines. Back smooth and flat. Length 5.7 cm., breadth 1.8 cm. (Cat. No. $\frac{2793}{87}$.)

8. (Pl. I, Fig. 9.) Small celt-shaped amulet of gray stone (serpentine?), with two incised parallel lines at the upper end and a round horizontal hole for suspension at the upper end. Central ridge on back retained. Length 4.1 cm., breadth 2.6 cm. (Cat. No. $\frac{2793}{88}$.)

9. (Pl. I, Fig. 20.) Celt-shaped, rectangular, long and narrow, plain amulet of polished gray stone. Pierced from the front with two round holes for suspension. The back smooth and flat. Length 15.3 cm., breadth 2.9 cm. (Cat. No. $\frac{2793}{89}$.)

10. (Pl. I, Fig. 18.) Celt-shaped amulet of gray serpentine, apparently representing the upper convex portion cut off from one of the typical celts of the burial-ground. The artist, after having abandoned an attempt to make a transverse perforation at the upper end, which apparently proved too thin, provided this amulet with two holes pierced in one of the longer sides. This amulet was consequently carried in a horizontal position. Length 14.7 cm., breadth 5.7 cm. (Cat. No. $\frac{2793}{90}$.)

11. (Pl. I, Fig. 19.) Celt-shaped narrow amulet of yellowish gray, impure gypsum without any ornamentation. Suspension hole transverse. Central ridge on back retained. Length 7.2 cm., breadth 2.2 cm. (Cat. No. $\frac{2793}{91}$.)

12. (Pl. I, Fig. 17.) Nearly triangular amulet, consisting of one of the lower quarters of a celt of saussurite, which has been divided both vertically and horizontally, and afterwards sculptured with the figure of a parrot seen in profile. The pierced eye also serves for suspension. This figure is carved on both sides, but the more perfect representation is on the left side. Length 5 cm., breadth 2.3 cm. (Cat. No. $\frac{2793}{92}$.)

13. (Pl. I, Fig. 15.) Axe-shaped amulet of white quartz. The upper part shows the head of a bird with crest and wings. The lower half of the blade is thin. Back convex. Length 5.5 cm., breadth 2.3 cm. (Cat. No. $\frac{2793}{93}$.)

14. (Pl. I, Fig. 16.) Amulet of white quartz in the shape of a highly conventionalized parrot (?) in profile. Suspension hole through the neck. This figure is apparently formed of a celt cut in two vertically. Length 5.4 cm., breadth 2.6 cm. (Cat. No. $\frac{2793}{94}$.)

15. (Pl. I, Fig. 6.) Amulet of gray stone in the shape of a parrot in sitting position, with a celt-shaped appendix to the lower portion of the body. Length 7.5 cm., breadth 3.1 cm. (Cat. No. $\frac{2793}{95}$.)

16. (Pl. I, Fig. 14.) Amulet of quartz carved from a small celt, in the shape of a human figure with the legs divided by a groove, hands held against the breast. Suspension hole through the neck. Material white and translucent. Length 4.4 cm., breadth 2.3 cm. (Cat. No. $\frac{2793}{96}$.)

17. (Pl. I, Fig. 11.) Small amulet of saussurite in the shape of a rudimentary human head (?). Breadth 1.8 cm., height 3 cm. (Cat. No. $\frac{2793}{97}$.)

18. (Pl. I, Fig. 4.) Small amulet of saussurite in the shape of the head of a bird with long, narrow beak, the suspension hole serving as an eye. Height 3 cm., (Cat. No. $\frac{2793}{98}$.)

19. (Pl. I, Fig. 3.) Small amulet of saussurite in the shape of a parrot's head. Height 2.4 cm. (Cat. No. $\frac{2793}{99}$.)

20. (Pl. I, Figs. 12, 13.) Round, flat bead of pale green bowenite. Diameter 1.5 cm. (Cat. No. $\frac{2793}{100}$.)

Several polished celts were also found. One typical specimen is inserted on Pl. XXIII, Fig. 7. Length 10.8 cm., breadth 7.8 cm. (Cat. No. $\frac{2793}{331}$.)

II. Objects of Clay.

1. (Pl. II, Fig. 1.) Unusually large vase, nearly cylindrical, but widening toward both ends. Resembles in shape a native drum, and may have served as one; encircled round the middle with three parallel, elevated, notched bands. Height 44 cm., diameter 23 cm. (Cat. No. $\frac{2793}{101}$.)

2. (Pl. II, Fig. 4.) Pot, nearly globular, with low rim, two handles. Color red. Height 9.9 cm., breadth 14 cm. (Cat. No. $\frac{2793}{102}$.)

3. (Pl. II, Fig. 7.) Pot, nearly globular, tripod with narrow rim. The body is nearly covered with vertical parallel incised lines. Color red. Height 9 cm. breadth 11.7 cm. (Cat. No. $\frac{2793}{103}$.)

4. (Pl. II, Fig. 3.) Cylindrical vase, legs and the upper part missing; bottom semiglobular. The body is encircled by two elevated notched bands. Color red. Diameter 10 cm. (Cat. No. $\frac{2793}{104}$.)

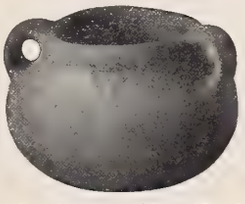


Fig. 57. Small pot. (Cat. No. $\frac{2793}{105}$.) $\frac{1}{2}$.

Fig. 58. Small pot. (Cat. No. $\frac{2793}{106}$.) $\frac{1}{2}$.

5. (Fig. 57.) Pot, small, semiglobular, with wide mouth and two band-like handles extending from the rim to the shoulder. Below the base of the rim there is a band with incised triangular designs. Color black. Height 4.4 cm., diameter 6.3 cm.

6. (Fig. 58.) Diminutive pot, depressed globular, with the shoulder encircled by three parallel incised lines. Rim straight, broad, decorated with the head of a

bird in relief on one side. On the opposite side there is a small handle extended to the shoulder. Color yellowish. Height 4.8 cm., diameter 4.5 cm.

7. (Pl. II, Fig. 6.) Diminutive depressed globular pot with a notched fillet encircling the shoulder. A circular hole shows where probably a little head had been inserted. Color red. Height 3.8 cm., diameter 4.6 cm. (Cat. No. $\frac{2793}{107}$.)

8. (Fig. 59.) Leg of clay vessel ornamented by small two-legged upright figure

FIG. 59. Leg of earthen vessel. (Cat. No. $\frac{2793}{108}$.) $\frac{1}{2}$.

FIG. 60. Leg of earthen vessel. (Cat No. $\frac{2793}{109}$.) $\frac{1}{2}$.

with the head of a parrot. The color was originally white with black and red ornaments, but the specimen is badly worn. Height 8 cm.

9. (Fig. 60.) Leg of clay vessel in the shape of a human figure adorned with a necklace. Color yellowish. Breadth over the shoulders 5.4 cm.

10. (Pl. II, Fig. 5.) Object of unknown use, resembling in general shape a pipe. The part taking the place of the stem is, however, not hollow. The inside of the bowl is blackened with soot. The walls are about 0.4 cm. thick. The outside, which is painted red, is covered with a wavy band decoration, now much obliterated. Length 8.3 cm. (Cat. No. $\frac{2793}{110}$.)

11. (Figs. 61, 62.) Ocarina of rare shape, in the form of a ring. The mouthpiece has the shape of an animal head, showing a row of teeth. On the opposite side two small wings (?) protrude, and between these the instrument is adorned with a small human figure in the round (head broken off). Almost the whole body of the instrument is covered with incised geometrical designs, the band ornamentation being partly pitted in the same manner as the ocarina previously described. (See Fig. 14.) Color black. Length 12.9 cm., breadth 9.2 cm.

12. (Pl. II, Fig. 2.) Ocarina with globular body pitted like those previously described, the incisions partly inlaid with white paint. Length 6.7 cm., diameter 4.1 cm. (Cat. No. $\frac{2793}{83}$).

On a high hill about twenty minutes distance from the burial-ground Carillo showed me on my first visit an ancient stone enclosure, which must have served as a courtyard. This enclosure was nearly rectangular in shape, about twenty-three meters long and eleven meters broad. The low walls were about half a meter broad and made up of rough water-worn boulders and stones. The general direction of the enclosure was E. 20° N. by W. 20° S.

An object here found was a fragment of stone with a sculptured eye (Pl. XXXII, Fig. 6), undoubtedly from one of the hollow animal heads of a metate, similar to those illustrated on Pl. XVIII, Fig. 4.

Quite close to the burial-ground near Carillo's house there were also some low but very irregular artificial heaps of stone. They were covered with thorny thick-

FIG. 61. Ocarina. Top view. (Cat. No. $\frac{27933}{III}$). $\frac{1}{2}$.

FIG. 62. Ocarina. Bottom view. (Cat. No. $\frac{27933}{III}$.) $\frac{1}{2}$.

ets. I tried to excavate what appeared to be a couple of small rooms, but the ground, which consisted of hard clay, contained nothing, and had apparently never been disturbed. Fragments of pottery were scarce at both of these structures.

Another ancient structure in the neighborhood of the burial-ground is a road about two meters broad and half a meter deep, cut in the clayey ground and running northward over the high sierras. I crossed stretches of this road, which in parts is well defined, about two miles north of the burial-ground, and it can be traced to one of the mountain peaks of the neighborhood, where the ancients probably had their settlements of perishable wooden huts. On the slopes and especially in the gullies of this mountain I found numerous pieces of large, crude pottery, plainly household vessels. According to Carillo and others the road of the ancients

can be followed for several miles northward. It was the first and only structure of the kind I met with in Central America.

In his work on Nicaragua, Vol. II, p. 334, Squier mentions what appear to be similar roads. He writes: "Amongst the most remarkable remains are traces of immense works in the district of Chontales, near the Indian town of Yuygalpa, on the northern shore of Lake Nicaragua, nearly opposite the city of Granada. They were observed by Dr. Livingston in his visit to the gold-mines of that region; and are described by him as consisting of trenches three or four yards broad at the bottom, and extending indefinitely, in a right line, across the savannas, and into the depth of the forest. He followed one for upwards of a mile."

II. ANTIQUITIES OF THE VELASCO COLLECTIONS FROM LAS GUACAS.

A. Objects of Stone.

1. *Tools and Weapons.*

(*a*) *Metates.*

On my first visit to Las Guacas in 1896, I found several large heaps of broken metates scattered around that part of the burial-ground which had been excavated, and made rubbings on heavy Japanese paper and sketches of a number of the sculptured ornaments which covered these fragments. During the excavations carried out for Padre Velasco a relative of his had been in charge of the working force during one season. He had made a collection of drawings of the most remarkable of the sculptured metates, which had been found complete and in situ, but crushed by the pressure of the soil. Although not sufficiently accurate to warrant reproduction, these sketches, which I then procured, are of interest, showing that quite a large number of the metates had the entire under side of the plate adorned with artistic, conventionalized, anthropomorphic and zoömorphic characters. As during my first stay in these parts no satisfactory agreement could be made with Padre Velasco for carrying on excavations at this place, I had to give up the idea of selecting material from the above-mentioned heaps. I was only able to buy a couple of large beautifully decorated metates, which had been put to actual use in the house of Antonio Carillo. I also obtained a few large, finely sculptured fragments, which were used as flagstones on the ground in his kitchen. These objects I took to the Ethnographical Museum in Stockholm.

When in 1903 I returned to Las Guacas, hoping to more thoroughly examine and recover part of the rich material which I had seen in the heaps, I found to my great disappointment that hardly anything remained. A considerable part of it had been used in constructing the walls of a large oven for sugar-manufacturing and the remaining pieces had been buried again during further excavations. On my first visit to the home of Padre Velasco in Santa Cruz he showed me in a large room more than three hundred metates from Las Guacas placed upon one another in rows and covering the wall up to the ceiling. On my second visit this collection was considerably reduced. Padre Velasco was constantly supplying the inhabitants of Santa Cruz, Nicoya, and the surrounding country with ancient metates from Las Guacas for household use. They were sold by him for eight to fourteen pesos apiece, and he had been able for a long time to satisfy the demand of the whole district. Only in a very few houses did I find modern metates from Puntarenas, which town imports the stones from Nicaragua. Occasionally a few are procured from the highlands, where they are manufactured at Cartago. According to the information and calculation of Padre Velasco, Antonio Carillo, and men employed on the excavations, there must at a low estimate have been found altogether two thousand metates in this burial-ground, though a very large portion of them were broken. In no other locality in Costa Rica, or for that matter in the whole of Central America, as far as my knowledge goes, has any similar extraordinary number of these implements been located in a single burial-ground. During my excavations on the spot, when about fifty complete metates were exhumed, not a single complete rubbing stone was discovered. Only a couple of small fragments were brought to light. On the contrary, in my previous excavations at Las Casitas I found "los manos" with several metates. Almost all the rubbing stones here used were cylindrical and more or less flattened, and so much longer than the breadth of the metate that the hands of the women when grinding could comfortably grasp both ends of the grinder on either side.

All the metates of Las Guacas, so far as I have been able to ascertain, are provided with three legs. There are two distinct types, distinguished by the shape of the legs, viz.: those with *cylindrical*, or in some cases *conical* legs, and those with *flat, nearly triangular* legs. In both groups the plate is evenly and gently curved upward before and behind; only a comparatively small number of specimens of the first group have a shallow depression deepening from all sides to the middle.

Specimens belonging to the former group are by far the most numerous. Of fifty-two metates which I excavated at Las Guacas only three belonged to the latter group. The metates of this group are, as a rule, of considerably larger size, the

average measurements being about fifty centimeters in length and thirty centimeters in breadth. At Las Guacas, however, I measured broken specimens of the immense size of one and a half meter in length and sometimes of a meter in width, and I also encountered diminutive specimens, like those figured on Pl. III, Figs. 1, 2. The latter undoubtedly were made for children. The breadth of the plate in the group with cylindrical legs is, as a rule, proportionately much larger than in the latter. In the former group by far the greatest number of specimens are plain without any ornamentation. Of the forty-nine specimens of this group, which I encountered during my excavations, thirty-three were plain, two decorated only on the upper side at both ends with a broad band with geometrical designs, four had similar decorative bands on the under side, either at both ends, or enframing the whole surface, six were decorated with bands on both the upper and lower sides, while four showed the enframed under side filled up with representations of highly conventionalized animal or human forms or with geometrical designs. The ornamentation of the cylindrical legs is prevalently limited to the lower end and is simply annular or composed of vertical grooves. The cylindrical legs are never perforated.

The second group having the flattened triangular legs, although much smaller, is the most interesting and most highly artistic. Though I myself found only three examples, I encountered in the burial-ground numerous scattered fragments of this type, and from Padre Velasco I secured a number of the best specimens which he had obtained. As has been observed, these metates are generally rather small in size and with a narrow plate, the average measurement being fifteen by seven centimeters. The plate is even and curved upward before and behind, but never hollowed out, or dished. They are cut from the most finely grained basaltic lava, and display in common several peculiar features, as has already been shown in the specimens described. Only a few specimens more crudely made are devoid of ornamentation, but most of them show lavishly rich sculpturings, many being, except on the two-thirds of the upper side of the plate which is used for grinding, entirely covered with ornamentation. These ornaments are of a different character from those found in the larger group. On the upper side there is usually a very broad rectangular field at the front end and only a narrow band at the back. While in the former group the geometrical design of the band consists of a guilloche or meander pattern, in this group a peculiar plaited or woven pattern of several variants prevails. The narrow edges of the borders of the plate in this group are, as a rule, covered with a meander design, while they are never decorated in the former group. The under side is usually covered with a plaited or highly conventionalized anthropomorphic design. Metates of this group often were evidently intended to represent in general

outline the form of some animal, and are then provided with a large, protruding head at the front, but not a single specimen of this class of metates shows any trace of the tail which always figures so prominently in the animal-shaped stools of the highlands. Others are provided with two loops at the front end. The legs, which are artistic and seldom plain, are most remarkable because of their oblong or circular perforations and the fact that they represent monkeys generally in a crouching position. The animal forms, besides that of man, embodied in, or sculptured on, metates of this group, are the monkey, the jaguar, birds of several distinct forms, and the alligator. In the first group, besides man, we find representations of the monkey, the ant-bear (one specimen), birds, and alligators, but the jaguar is conspicuously absent. This kind of metates is known, too, from other localities on the peninsula, and is said to be especially numerous at Sardinal. It may not belong to the Las Guacas culture proper, but is possibly of alien origin. However, this is one of the questions which can only be settled by future investigations.

Neither of the forms of metates found at Las Guacas is, as far as our knowledge goes at present, encountered on the highlands, or on the Atlantic coast, although of course stray pieces may have found their way to some localities. Dr. Carl Sapper in his paper "Huacas der Halb-Insel Nicoya," referred to above, makes the following statement: "The metates of the burial-ground of Las Huacas resemble the type of northern Central America in the respect that both forms are provided with three legs, while the metates of the highlands of Costa Rica and those of the province of Chiriqui have four legs." When Sapper speaks of the metates on the highlands of Costa Rica having four legs, he undoubtedly refers to the small, artistically executed metate-shaped implements, which forms in the publications of W. H. Holmes and others have been generally designated as "stools," and are supposed to have had only ceremonial uses. The common household metates or grinding stones of the highlands, besides the flat natural boulders, are mostly small, crude, flat, and provided with three small knobs as legs. On Pl. 15, Fig. 4, in my "Archæological Researches in Costa Rica," there is shown a typical specimen of the metate of the highlands, excavated by me at Williamsburg on the Atlantic coast, where the same form also prevails. Pl. 78, Fig. 9, in the same work illustrates a typical specimen of the grinding-stone used with the metate of the highlands. It is rectangular, flat, and of small size. No attention, however, was paid by collectors to these simple objects in former times, undoubtedly on account of their entire lack of decorative features.

Besides these metates there occurs at certain localities on the highlands, principally near San José, another type of metates having the shape of a low three-

legged table with cylindrical, tapering legs. The plate is never curved as in the Nicoyan forms, but is entirely flat, and surrounded with a low elevated rim. It is rectangular in shape with somewhat rounded corners and of considerable thickness. Most of the specimens appear decorated with a succession of knobs representing small rudely executed animal heads along the lower border of the rim, others are plain. Dr. Ferraz[10] found not less than nine similarly decorated metates associated with the very remarkable "mesa altar" he has described from San Isidro near the capital. I obtained four specimens for the Carnegie Museum from the same neighborhood. Metates with four legs are today common in the houses of the present inhabitants on the highlands, but these are all of modern manufacture from the stone-quarries near Cartago. None of a similar shape has been found in any of the ancient graves or sites.

The Nicoyan type of metate, having flat, triangular, and perforated legs, has been already illustrated by Squier[11] from Nicaragua by a specimen described as having been dug up at Leon during his residence there.

Further north along the same coast in the parts of Salvador and Guatemala which I visited, these metates are supplanted by crude forms, usually devoid of ornament. South of Nicoya on the mainland of Costa Rica the types under discussion are replaced by another of oval shape, concave, and without legs, which I discovered in my excavations at Carrizal near Puntarenas.

In contrast to the superb ancient metates of this portion of Costa Rica it is of interest to compare those in actual use today by the Talamanca Indians of Southeastern Costa Rica. Their stone mills (see Pl. XXI) still used in every palenque are the most primitive ever used by man, consisting of a large flat river boulder on top of which is placed another smaller, but still unusually large, oval, heavy crushing stone, which the woman works with a partly rocking motion when preparing the corn. This type of rocking mills perhaps points back to a time when corn was not known at all or of little importance in comparison with various hard-shelled fruits of trees, some of which are still employed at times when there is a failure of the crop of corn.

The lavish ornamentation of the Nicoyan metates is remarkable. Even the under side of the plates of these artefacts has been embellished with elaborate designs. This has rarely been observed outside of the area of this Central American culture. Figures of the only two specimens of metates thus ornamented from

[10] Ferraz, Juan Fernandez: "Informe Relativo al Año Economico de 1899–1900 del Museo Nacional de Costa Rica." San José, 1900, p. 23.

[11] Squier, E. G., "Nicaragua, Its People, Scenery, etc." New York, 1860, pp. 256–7.

other localities which have come to my knowledge are here reproduced. Figure 63 shows a metate given by Strebel in his "Alt Mexico," Vol. II, Pl. XIV, Fig. 10. This metate was found in the region of Jalapa and Coatepec, in the state of Vera

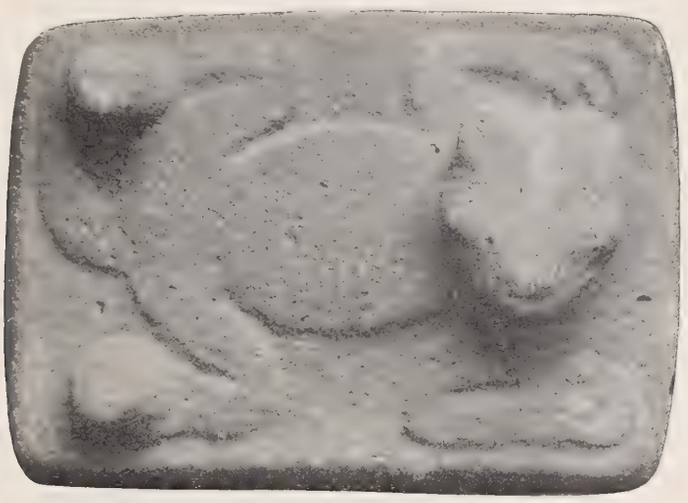


FIG. 63. Metate from the State of Vera Cruz, Mexico.

Cruz. Strebel identifies the animal as "a frog or a lizard." The metate illustrated by Figures 64 and 65, which strikingly resembles the former, is supposed to have been obtained in Guatemala. It is contained in the famous collection of an-

FIG. 64. Under side of metate in collection of Mr. George G. Heye. ¼.

tiquities formerly belonging to Joseph Jones, now in the possession of Mr. George G. Heye of New York City. The figure plainly represents a puma or some allied animal. Length 36 cm., breadth 27 cm.

The similarities in shape and ornamentation between the metates of Guanacaste and those of Porto Rico and other islands of the West Indies have been pointed out by Dr. J. Walter Fewkes and others.

Description of some of the most interesting forms of the metates of the Velasco collections and of specimens purchased by me at Las Guacas, in 1896, from Antonio Carillo follow.

Fig. 65. Side view of metate in collection of Mr. George G. Heye. ¼.

1. *Metates with cylindrical or conical legs.*

1. (Pl. X, Figs. 3, 4; Pl. XI, Fig. 1.) Large rectangular metate. On the upper side there is at each end a broad band, filled with a guilloche design. Inside the frame there is a design, which judging from less conventionalized figures on other metates from this burial-ground, may stand for two opposing human figures with large head-dresses. The legs of the metate are ornamented with encircling and longitudinal grooves. Broken in two places; one leg missing. This metate had been used in Carillo's household., but was discarded and procured for the Stockholm Museum. Length 64.5 cm., breadth 38.5 cm., height 21 cm.

2. (Pl. XI, Figs. 2, 3, 4.) Large, rectangular metate with the upper side ornamented at each end by a broad band with a guilloche design. The under side is enframed by four narrow, parallel bands, and this frame encloses what probably stands for the detached limbs of two opposing highly conventionalized human figures. The legs of the metate are encircled by parallel grooves. One leg having been broken off, I was able to secure this superb specimen from Carillo for the Stockholm Museum. Length 61 cm., breadth 41 cm., height 21.6 cm.

3. (Pl. XII, Figs. 1, 2.) Metate with the upper side of the plate plain, the under side covered with a realistic figure of a monkey with outstretched limbs and with the end of the tail curved. The legs of the metate are encircled at the middle with two grooves from which four or five straight parallel vertical grooves descend to the end of the legs. Length 48.5 cm., breadth 28 cm., height 16 cm. (Cat. No. $\frac{2939}{3431}$.)

4. (Pl. XIII, Figs. 1, 2.) Metate with the upper side at both ends adorned with a broad band with a meander design, which at each end terminates in a highly conventionalized animal (alligator) head. The under side presents a broad sculptured frame of intricate double meander design and in the middle of the rectangular enclosure there is a realistic figure of a monkey in sitting position with both arms held up in front of the face and the tail turned up above the head and almost coiled round the leg of the metate. The lower half of the metate-legs is adorned principally with vertical grooved ornamentation. Length 34 cm., breadth 24 cm., height 11.5 cm. (Cat. No. $\frac{2438}{1412}$.)

5. (Pl. XII, Figs. 3, 4.) Metate with the upper side plain, the under side occupied by the design of an alligator with outstretched legs, inside a broad frame of intricate geometrical designs. The lower ends of the legs are adorned with an encircling elevated band, from which parallel vertical grooves descend to the end of the legs. Length 53 cm., breadth 33.5 cm., height 18 cm. (Cat. No. $\frac{2438}{1413}$.)

6. (Pl. XIV, Figs. 3, 4.) Metate with the upper side plain, the lower side showing on its surface two crude animal forms (alligators?) with outstretched limbs and tails extended upon the legs of the metate, 35 cm. long. The whole under side is enframed by an elevated ridge. The legs are conical and short. Length 57 cm., breadth 37 cm., height 10.5 cm. (Cat. No. $\frac{2939}{3429}$.)

7. (Pl. XIV, Figs. 1, 2.) Small metate with the upper side plain, the under side entirely covered with sculptured designs in relief, representing two large and one small alligator, with outstretched limbs, enframed by an elevated ridge, which is notched at one side. Legs encircled by parallel, notched bands. Length 36 cm., breadth 27.5 cm., height 8.5 cm. (Cat. No. $\frac{2939}{3430}$.)

8. (Pl. XIII, Figs. 3, 4.) Small metate with the upper side plain, the under side covered with the sculptured figure of a human being with arms and legs spread, fingers and toes marked, the head adorned with a head-dress and large bell-shaped ear-plugs. The space under the right arm seems to be filled up with a small roughly executed figure with head-dress, and below the left arm there appears to be the design of a head-dress. The legs are adorned with three parallel encircling grooves near the ends. Length 35 cm., breadth 22.5 cm., height 9.5 cm. (Cat. No. $\frac{2438}{1411}$.)

2. *Metates with flattened triangular legs.*

1. (Pl. XV, Figs. 1–4.) Metate with the upper side adorned at the front with a sculptured field 10.5 cm. broad, with a plaited knot-design and at the back end with a narrow band with a simple angular design. The margins of the sides are adorned with a simple design of three or four short parallel lines alternately placed

in horizontal and vertical positions. On the under side at the front end there are two oblong loops, each probably representing the united arms of a highly conventionalized human or simian figure. Each of the legs of the metate is formed by a simian figure in sitting position, the tail extended parallel to the back and joined to the neck. Length 38 cm., breadth 18 cm., height 15 cm. (Cat. No. $\frac{2438}{14410}$.)

2. (Pl. XVI, Figs. 1–4.) Metate of the same type as the above. The upper side shows a rectangular broad field with a plaited knot-design at the front end, but none at the back. The under side is occupied by a plaited design, possibly representing a highly conventionalized human figure. The legs of the metate, which are provided with longitudinal slits, represent squatting simian figures. The double loops at the front end resemble the heads of birds. Length 47 cm., breadth 28.5 cm., height 12.5 cm. (Cat. No. $\frac{2939}{3428}$.)

3. (Pl. XVII, Figs. 1, 2.) Metate of the same type as the preceding. The upper side is adorned with a much worn plaited knot-design at the front. At the back there is a narrow band with the decoration worn off. The under side is covered with a peculiar band-like design, possibly representing a conventionalized human face and body. The loops at the front are broken. The legs have longitudinal slits and apparently originally represented squatting simian figures, as seen in the former and many other related specimens, but the original outlines apparently have been lost. Length 34 cm., breadth 18 cm., height 13.4 cm. (Cat. No. $\frac{2438}{09}$.)

4. (Pl. XVII, Figs. 3, 4.) Metate in the shape of a jaguar with a large hollow head protruding from the front. The upper side shows at the front end a broad sculptured band with two highly conventionalized human faces. This ornamentation extends over the back and sides of the neck. (Compare Pl. IX, Fig. 2.) At the back there is a narrower band with meander design. The edges of the long sides are also covered with meander designs. The under side is plain. The legs have longitudinal slits. Length 50 cm., breadth 20.5 cm., height 12.5 cm. (Cat. No. $\frac{2939}{3427}$).

5. (Pl. XVIII, Figs. 1, 2, 3.) Metate in the shape of a jaguar with protruding hollow head. The upper side has at the front a broad rectangular field adorned with a plaited knot and with meander and other geometrical designs. At the back there is a narrow band with a meander design. The neck and top of the head, the side edges of the plate, and the legs are also adorned, mostly with meander designs. The legs are each perforated with two circular holes. Length 69 cm., breadth 28 cm., height 22.5 cm. The specimen belongs to the National Museum in San José. Obtained from Nicoya.

6. (Pl. XVIII, Fig. 4.) Metate of unique shape. A large, oblong, hollow and

ornamented animal head serves as the front leg, extending in a vertical position from the front edge of the plate. The hind legs have each two perforations surrounded by grooves. Length 40 cm., breadth 20 cm., height 14.5 cm. The specimen is contained in the National Museum in San José. The locality, probably by mistake, is given as Aguas Calientes in the highlands.

7. (Pl. XIX, Fig. 1.) Metate with a large bird head protruding in front, the long narrow beak curved and joined to the front leg of the metate. The upper side of the plate is adorned with a broad band with a plaited knot design (?) and a narrow band with meander designs at the back. The almost rectangular legs are adorned with two parallel grooves along the edges on the outside. The front leg has three, each of the hind legs two slits. Length 45 cm., breadth 20 cm., height 15 cm. (National Museum of Costa Rica.)

8. (Pl. XX, Figs. 1, 2.) Metate in the shape of a bird with crested head. The upper side shows as usual a broader band, a plaited or woven design at the front end, and a narrower band with meander pattern at the back. The edges of the long sides are adorned with two short parallel bands alternately placed horizontally and vertically. The legs are covered with simple geometrical designs. The front leg has three, each of the hind legs two, longitudinal slits. Length 53.5 cm., breadth 24 cm., height 17 cm. (Cat. No. $\frac{2939}{34266}$.)

9. (Pl. XX, Figs. 3, 4.) Metate in the shape of a bird with long curved neck and a large beak, the head adorned with three rows of feathers, six in each. On the upper side there is a broader field with a plaited design at the front and a narrower band with a meander design at the back. The side edges are also adorned with a meander design. The under side is plain. The legs are broken, showing longitudinal slits. Length 55.5 cm., breadth 22 cm. (Cat. No. $\frac{2939}{34225}$.)

10. (Pl. XIX, Figs. 2, 3, 4.) Metate with a small rudely designed head of a bird (?) protruding from under the edge of the front end. The upper side shows at the front a beautiful regularly plaited design. The under side is covered with another plaited design, possibly that of a human figure. The legs are without ornaments or perforations. Length 48 cm., breadth 44.5 cm., height 13.5 cm. (Cat. No. $\frac{2438}{14088}$.)

Rubbers or Grinding-stones.

1. *Cylindrical Grinding-stones.*

As already mentioned nearly all the grinding-stones, or rubbing-stones for metates, which have been found at Las Guacas, are flattened cylindrical and entirely devoid of ornamentation. Only a single specimen, which was richly sculp-

tured at one end, was encountered here, and was for some time in the possession of Velasco. Two typical specimens of the cylindrical stones are illustrated.

(*a*) (Pl. V, Fig. 2.) Grinding stone of basaltic lava. Excavated by the writer at Las Casitas, now in the Stockholm Museum. Length 47 cm.

(*b*) (Pl. V, Fig. 3.) Grinding-stone of the same material. Excavated at Las Guacas by Carillo, and now in the Stockholm Museum. Length 56.8 cm.

2. *Stirrup-shaped Grinding-stones.*

Only a few specimens of this singular, highly developed form of grinding-stone have been found at Las Guacas. When using this tool the worker grasped the side bars with both hands, the thumbs resting on the top bar. Several metates on which only these, or other small, simple, grinding-stones with a convex base could have been used, have been encountered at Las Guacas. One similar metate, which I exhumed, is illustrated on Pl. III, Fig. 5. The stirrup-shaped form of rubbing-stone has been encountered in a few localities in the highlands also, as on Irazu, and by me at Orosi. (See Pl. 69, Fig. 1, in "Archæological Researches in Costa Rica.") In 1896 I discovered some specimens during excavations at Carrizal near Puntarenas. Nowhere in Costa Rica has this form been found in any number. The center for its distribution is still unknown. Some specimens are illustrated on Pl. XXII. They are all made of basaltic lava.

(*a*) (Pl. XXII, Fig. 6.) Grinding-stone, ornamented with five knobs on the top bar, the central opening oval, base slightly curved, convex, showing wear from use. Height 13.8 cm., breadth 14 cm. (Cat. No. $\frac{2438}{1402}$.)

(*b*) (Pl. XXII, Fig. 4.) Grinding-stone with two opposing human heads sculptured on the top corners. Base curved, convex, central opening almost rectangular. Found at Aguas Calientes in the highlands. Reproduced for comparison. Height 15 cm., breadth 15 cm. (Nat. Mus. of Costa Rica.)

(*c*) (Pl. XXII, Fig. 3.) Grinding-stone with a small bird on the top bar. Base almost straight, convex, central opening nearly square. Height 12.2 cm., breadth 11.7 cm. Found in Nicoya. (J. Cooper.) (Nat. Mus. of Costa Rica.)

(*d*) (Pl. XXII, Fig. 2.) Grinding-stone with saddle-shaped top bar, the ends of which are each adorned with a human head. Base curved, convex. Height 13.5 cm., breadth 14.5 cm. Found at Aguas Calientes (?) in the highlands. (Nat. Mus. of Costa Rica.)

(*e*) (Pl. XXII, Fig. 1.) Grinding-stone, representing a highly conventionalized human face with head ornament. The head-dress is composed of two opposing animal heads. Compare with the ornamentation of celt-shaped amulets (Pl.

XXXIV., Figs. 1–8). The eyes and mouth are represented by the openings. Base nearly straight. Height 11.4 cm., breadth 14.3 cm. (Cat. No. $\frac{2438}{1404}$.)

(*f*) (Pl. XXII, Fig. 5.) Grinding-stone with two knobs on the top for strengthening the grasp of the hands, base nearly straight. Some similar form, which for carrying or suspension was perforated at the center, afterwards presumably served as a prototype for the stirrup-shaped form. Height 8.5 cm., length 14.5 cm. (Cat. No. $\frac{2939}{3422}$.)

The stirrup-shaped grinding-stone has not been found in any other state of Central America, but it occurs in Mexico. In Dr. Hermann Strebel's work, "Alt-Mexico," there are figured two specimens from the state of Vera Cruz. Both specimens are described as mullers, one of them having been found in the Misantla region, and probably the other also. (Compare "Alt-Mexico," Vol. II, Pl. VIII, Figs. 54, 55.) According to information given me by the German archeological explorer, Dr. Wilhelm Bauer of the city of Mexico, similarly shaped implements are met with, although sparingly, in the valley of Mexico.

Passing northward no stone implement of this shape is met with before the northwestern coast of British Columbia and Alaska is reached. In an article in the "American Anthropologist" Harlan I. Smith[12] figures and describes three stone implements of forms in the main resembling those of southern origin mentioned above. "These implements or hammers," writes Smith, "seem to have been used for rubbing as well as for pounding."

On the South American continent this kind of rubbing-stone never seems to have been encountered.

On the island of Kauai in Hawaii the natives made use of poi-pounders, implements having the shape of rings or stirrups, resembling the American forms, but not used for rubbing purposes. (Compare Figure 61 in "Handbook to the Bernice Pauahi Bishop Museum in Honolulu" by Dr. William T. Brigham.)

(*b*) *Celts.*

Celts are very numerous at Las Guacas, having been encountered in thousands, although only a comparatively small portion of those found were preserved. The commonest celts, which are most typical of this burial-ground, are unusually long and thick in comparison with those usually found in Central America, the average length being between twelve and eighteen centimeters, and the width from four to seven centimeters. However, a number of smaller specimens also occur. In shape

[12] Smith, Harlan I., "Stone Hammers or Pestles of the North West Coast of America," *American Anthropologist* (N. S.), Vol. I., April, 1899, pp. 363–369.

the celts vary in section from oblong elliptical to nearly circular. The edge is curved, in some specimens nearly semicircular, only in a few specimens straight. They are nearly all made of very finely grained greenstone, varying in color from light-gray to yellowish. They are beautifully polished, except at the upper end, which served for hafting.

The hundreds of specimens from Las Guacas, which I have observed, show unbroken edges without any splits or marks of battering. Very likely these tools served for cutting down forest trees, when clearing the ground in the manner which was customary in the region. In felling trees the natives resorted to the use of fire, with their stone axes chopping away the charred wood, when the trunk near the base had been partially consumed. They may have served also as tools for making canoes and household objects of wood. Possibly too they were used as weapons, but never as chisels or wedges by stone-cutters, as undoubtedly was the case in the highlands, as at Orosi. There similar celt-shaped tools often were employed for splitting and shaping the stone slabs for the cists, to judge by their badly mutilated and split edges. (Compare my "Archæological Researches in Costa Rica.")

At Las Guacas no celt of the common type of the highlands, having a distinctly angular section, seems to have been found.

Pl. XXIII, Figs. 1–5 and Fig. 7 shows some of the commonest types of the celts of Las Guacas. Pl. XXIII, Fig. 3, illustrates a form with nearly parallel straight sides and well rounded section. Pl. XXIII, Fig. 1, shows a nearly bell-shaped specimen, which is rather rare, and Pl. XXIII, Fig. 5, illustrates another rare variety, which is contracted at the upper end. Celts seem to have been the principal stone tools of the Indians of Nicoya.

Comparison may be made with the celts illustrated by Figs. 18, 50, and 55 in the text.

The measurements of the celts illustrated on Pl. XXIII are the following:

Fig. 1.	Length	18.8 cm.,	breadth	7 cm.,	thickness	5.4 cm.
Fig. 2.	"	19 cm.,	"	9.3 cm.,	"	5.5 cm.
Fig. 3.	"	22.1 cm.,	"	6.2 cm.,	"	4.9 cm.
Fig. 4.	"	16.3 cm.,	"	6.8 cm.,	"	3.7 cm.
Fig. 5.	"	13.5 cm.,	"	6.9 cm.,	"	4 cm.
Fig. 7.	"	5.4 cm.,	"	5.4 cm.,	"	2.2 cm.

Two celts were found at Las Guacas, which are adorned with incised geometrical designs. One is shown on Pl. XXXIV, Fig. 9.

(*a*) (Pl. XXXIV, Fig. 9.) Celt of serpentine (?) adorned on each side with a transverse incised band inclosing a row of three circular incisions, each having a

round depression in the middle. Below the band there is also on each side a similar circular mark, resembling those often used in zoömorphic celts for indicating the eye. This specimen has no hole for suspension. Length 7.3 cm., breadth 3 cm. (Cat. No. $\frac{29339}{16225}$.)

(*b*) (Pl. XXXIV, Fig. 14.) Celt of serpentine (?) resembling Fig. 9 on the same plate. No hole for suspension. Length 7.9 cm., breadth 2.9 cm. (Cat. No. $\frac{29339}{16224}$.)

(*c*) *Axes.*

There occurred in this burial-ground at Las Guacas two forms of large, double-bladed, sharp-edged axes. Figs. 1 and 2, on Pl. XXIV, illustrate one form, which is almost semilunar, with two conical sharp knobs on the upper convex side. Figs. 3 and 4, on Pl. XXIV, show another and commoner form, having two broad blades. During the excavations of Padre Velasco similar axes were sparingly found in various parts of the burial-ground. They seem never to have been met with in any number. I found a few specimens in my excavations at Las Casitas and one at Las Guacas, the latter figured on Pl. I, Fig. 1, and described above. All of these axes are of slate and probably served as battle-axes. The measurements of the axes illustrated on Pl. XXIV, are the following:

Fig. 1. Length 20.2 cm., breadth at the center 5.1 cm., thickness 4.3 cm.

Fig. 2. Length 14.6 cm., breadth at the center 4.8 cm., thickness 3.1 cm.

Fig. 3. Length 15.9 cm., breadth 5.9 cm., thickness 2.4 cm.

Fig. 4. Length 15.8 cm., breadth 4.7 cm., thickness 3.2 cm.

A unique specimen of a double-bladed ax is illustrated on Pl. XXXIII, Fig. 6. It is provided with two elevated parallel and transverse bands representing the strings for the hafting. Length 13.8 cm., breadth at the middle 5.2 cm.

(*d*) *Bark-scrapers.*

A number of these small, neat, and elaborately executed tools were in use among the Indians of Las Guacas. (Compare the notes upon these objects in the description of the specimen I found at Las Guacas, p. 31.) Pl. XXIII, Figs. 8, 9, 10, shows three bark-scrapers in the collections of Padre Velasco varying in shape. Pl. XXIII, Figs. 8 and 9, are both double-grooved. Pl. XXIII, Fig. 10, displays three longitudinal grooves on the upper side, the specimen perhaps having not been completed by its maker. The measurements of the bark-scrapers on Pl. XXIII, are the following:

Fig. 8. Length 7.9 cm., breadth 6.2 cm. (Cat. No. $\frac{2438}{275}$.)

Fig. 9. Length 6.2 cm., breadth 5.5 cm. (Cat. No. $\frac{2438}{276}$).

Fig. 10. Length 8.6 cm., breadth 6.9 cm. (Cat. No. $\frac{29339}{77}$.)

(*e*) *Polishing Stones.*

These are extremely numerous and usually consist of pebbles from streams or the seashore. They are nearly all of more or less translucent agate and about the size of a pigeon's egg. They were probably used principally for polishing earthenware. Several specimens have been figured (see Figs. 19, 21, 22, 44, 45 in the text).

(*f*) *Various Stone Implements.*

Among the numerous objects excavated by the force employed by Padre Velasco at Las Guacas there undoubtedly were a large number of simple tools and other worked stones, which, being devoid of any ornamental appearance, were again buried or lost. Among those which escaped this fate there are a few which are described below.

FIG. 66 Cutting-tool of slate. (Cat. No. $\frac{2939}{1833}$.) $\frac{1}{2}$.

(*a*) (Pl. XXXII, Figs. 1, 2.) Shows two views of a block of pale green bowenite, from which celts have been cut. It was found by the writer in soil thrown up at Las Guacas. The length is 11 cm., the breadth 3.9 cm. (Cat. No. $\frac{2793}{126}$.)

(*b*) (Pl. XXXII, Figs. 3, 4.) Represents a large pebble of bluish-green jade from which celt-shaped amulets were cut. Fig. 4 shows one of the sides of the pebble upon which the beginning of a cut has been made. Length 11.8 cm., breadth 6.2 cm. (Cat. No. $\frac{2939}{80}$.)

(*c*) (Pl. XXXII, Fig. 5.) Represents a cylindrical core of gray stone, which had been evidently bored out of the block by working from both sides, probably for a bannerstone. Length 4.1 cm., diameter 2.5 cm. (Cat. No. $\frac{2939}{81}$.)

(*d*) (Pl. XXXII, Fig. 6.) Portion of the hollow animal head of a metate, showing the eye. Found by the writer in the neighborhood of Las Guacas. Compare Pl. XVIII, Fig. 4. Length 12.7 cm. (Cat. No. $\frac{2793}{127}$.)

(*e*) (Pl. XXXII, Fig. 7.) Arrow-head of chipped chert. Length 6.7 cm., breadth 2 cm. (Cat. No. $\frac{2438}{41}$.)

(*f*) (Pl. XXXII, Fig. 8.) Smoothing or polishing stone. It is of slate, celt-shaped, flat, and thin. Length 18.6 cm., breadth 5.9 cm. (Cat. No. $\frac{2438}{44}$.)

(*g*) (Pl. XXXVII, Figs. 25–26.) Sharpening or polishing tool. An oblong, flat, thin piece of black slate, which on both sides shows several longitudinal grooves. Length 14.5 cm., breadth 6.5 cm., thickness 1.4 cm. (Cat. No. $\frac{2438}{45}$.)

(*h*) (Fig. 66.) Thin cutting tool, semilunar in shape, of black slate, with a sharp edge. Length 12.5 cm., breadth 4.3 cm.

(g) Banner-stones or Club-heads.

A group of stone objects of highly interesting and rather unique character found in the burial-ground at Las Guacas are the banner-stones or ornamental clubs or maces. Concerning this group of stone artefacts what has been said above regarding metates may be repeated. At no other locality in all Central America, so far as I have been able to ascertain, has such a large number of similar implements been found. On the uplands of Costa Rica, with the exception of the beautiful double-bladed serrated ax or banner-stone (Archæological Researches in Costa Rica, Pl. 60, Fig. 6), which form seems to be limited to the burial-grounds of a small district near Cartago, only a few clubs, shaped like rings or cog-wheels, have been here and there encountered. In the vicinity of San José there were exhumed during my last stay in an ancient burial-ground a few clubs of the type of those found at Las Guacas, which I procured. They had probably in olden time found their way to this place through barter. On the peninsula of Nicoya it seems strangely enough that this class of implements has as yet never been found at any other spot than Las Guacas. Future excavations, however, will show the limits of their distribution in these parts. Nearly all of these clubs represent a head, human or animal. They can be classified in groups according to their shape. They represent, *1, human heads; 2, mammal heads; 3, the heads of birds; 4, birds; 5, two-legged monsters; 6, alligators; 7, clubs without any zoömorphic characters.* All the clubs are comparatively small and are perforated in the center by a large circular hole for the handle which has been drilled through them. In the head-shaped clubs it is the large and heavy front portion which is carved into a face or head, while the posterior half is simply ring-shaped with rather thin walls. In the clubs which embody birds or alligators and have the perforations in the center of the body, the back portion (tail) is cone-shaped. The highly ornamental, zoömorphic features of these implements and their size, which is in many cases too small to have admitted of their use for practical purposes, bear witness to their purely symbolical and ceremonial character.

Most of these clubs illustrate in the most perfect manner the employment of the hollow cylindrical drill. The center perforation or shaft-hole often plainly shows a succession of circular striæ at regular intervals, and in the middle there is often a deeper furrow, where the borings from each end met. Pl. XXXII, Fig. 5, illustrates one of the detached cylindrical center-cores of a club. The ridge at the meeting place near the middle is plainly visible on this specimen. On many of the heads the circular base of the core is purposely left in order to form an eye or an ear. It is possible that in the round pits, which have served as eyes in many of these objects, pieces of mother-of-pearl or other perishable material were inserted.

Some of the central shaft-holes are plain and smooth all through, showing no furrow near the middle. In some specimens the hole might have been formed by drilling from only one side.

As is well known, it was with water and fine hard sand that this drilling was done. Dr. Charles Rau in his essay[13] writes: "It is very likely that the hollow drills of the aborigines of North America were pieces of that hard and tough cane, *Arundinaria macrosperma* Michaux, which grows abundantly in the southern part of the United States, mostly along the banks of large rivers, and forms at present an article of trade being used for pipe-stems and fishing-rods. This cane varies considerably in thickness; sometimes as thin as a straw, it assumes, when fully grown, the diametral proportions of a strong rifle-barrel and even of larger cylindrical objects, in which case it reaches the enormous height of 25–30 feet. A piece of this cane from which the knotty joints have been cut, forms a regular hollow cylinder sufficiently strong to be used as a drill."

Professor W. H. Holmes in his "Archæological Studies among the Ancient Cities of Mexico," Part II, pp. 304–309, describes an onyx tablet from the valley of Mexico which had broken and revealed the presence of a tubular drill of bone probably from the leg of a crane or other large bird, 2.75 inches long and 0.375 of an inch in diameter. It was shattered and worn at the upper end, while the lower end or point had the appearance of having been freshly cut off.

Professor M. H. Saville in the "Bulletin of the American Museum of Natural History," Vol. XIII, Article XI, pp. 105–107, has described and figured an onyx jar in process of manufacture, which was found in Oaxaca. This specimen illustrates the use of the hollow drill in exactly the same manner as the club-heads.

In the neighborhood of the pueblo of Nicoya near ancient remains I observed spots covered with thickets of an *Arundinaria* sp., undoubtedly in former times cultivated here. From an Indian I obtained a flute which he had made from a piece of this kind of cane. In Salvador amongst the Pipiles I found this same cane in certain localities planted on their fields and used extensively for the manufacture of baskets, screens, etc.[14]

Some specimens of the clubs show circular pits for eyes, which have been made with a solid body, probably a wooden stick. These pits are conical, not very deep, and show no circular striæ.

To judge from the thickness of the walls left by the hollow drill most of the larger drill-holes of the clubs apparently could have been produced with similar

[13] Rau, Charles, "Drilling in stone without metal," Smithsonian Report, 1868, p. 399.

[14] Hartman, C. V., "Ethnografiska Undersökningari Salvador," Stockholm, 1901, p. 308.

canes. For the smaller cylindrical holes, however, some tube with much thinner walls must have been employed, a tool of metal or bone.

1. *Bannerstones Having the Shape of Human Heads.*

(*a*) (Pl. XXV, Fig. 7.) Head of brown stone (impure gypsum?), the front adorned with a hair ribbon of herring-bone design; eyes represented by oblong conical pits, mouth wide open, ears very large. Height 5.8 cm., breadth 6.8 cm. (Cat. No. $\frac{2939}{213}$.)

(*b*) (Pl. XXV, Fig. 6.) Head of gray gypsum with projecting ears, the eyes indicated by round conical pits. Height 5 cm., breadth 8.9 cm. (Cat. No. $\frac{2438}{256}$.)

(*c*) (Pl. XXV, Fig. 3.) Head of jade with a parrot with spread wings seated on its top. This is the only club-head in the collection which, instead of having an annular perforation through the center, is partly hollowed out from behind and has holes for fastening to the staff drilled through to the base of the wings. The teeth of this head consist of the walls left between the drill holes of the opening of the mouth. Height of object 8.5 cm., breadth of head 5.4 cm. (Cat. No. $\frac{9239}{214}$.)

(*d*) (Pl. XXV, Figs. 4–5.) Finely executed death's head of opaque, white, polished stone. The teeth in both jaws are distinctly marked by rectangular incisions. The mouth has been formed by sawing from the front and drilling from one corner of the mouth to the opposite. The eyes are each formed by one hollow drill-hole, the base of the core, which has been removed, serving as the pupil. The ears are made by first applying a large hollow drill and leaving the base of the circular core in its place, upon which the center is again drilled with a small circular hole. Height 8.4 cm., length 10.9 cm. (Nat. Mus. of Costa Rica, No. 8923.)

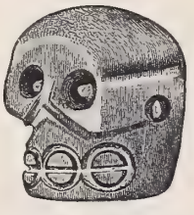


Fig. 67. Death's head from Chichen-Itza. $\frac{1}{1}$.

(*e*) (Pl. XXV, Figs. 1–2.) Death's head of white, polished stone. In this specimen the mouth has been made by drilling from one corner of the mouth to the other and by two drill holes from the front, the walls serving as teeth. There are also tooth marks on what appear as the lips. Height 7.3 cm., length 9.9 cm. (Nat. Mus. of Costa Rica No. 10966.)

Fig. 67. A death's head somewhat resembling the above was found at the ruins of Chichen-Itza in Yucatan and is here reproduced for comparison. It was figured and described by Dr. Arthur Scott[15] and also reproduced by Dr. Charles Rau.[16] It is described as made of silicified wood, measuring 0.25 by 0.22 cm. and to have in

[15] Scott, Arthur, Remarks on Ancient Relics of Maya Sculpture. Smithsonian Report, 1871, pp. 423–435.

[16] Rau, Charles, Archæological Collections of the United States National Museum. Smithsonian Contributions to Knowledge, 1876, p. 55.

the place of ears two holes bored, one laterally and one from the back, so as to meet each other at a right angle.

As seen in the figure the eyes, teeth, and earholes are all formed with a hollow drill. The drilled teeth in this specimen are, however, executed in a manner different from that of the Costa Rican stone heads. The mouth consists of a row of four rings of equal size, which by a diagonal straight narrow groove are divided at the center, thus forming four half-circular teeth in each jaw.

2. *Mammal Heads.*

(*a*) (Pl. XXVI, Fig. 1.) Head resembling that of a dog, of grayish white quartz (?). Height 4.9 cm., breadth 7.5 cm. (Cat. No. $\frac{2939}{224}$.)

(*b*) (Pl. XXVI, Fig. 2.) Small head of gray stone. Height 5.6 cm., breadth 8.4 cm. (Nat. Mus. of Costa Rica, No. 3361.)

(*c*) (Pl. XXVI, Fig. 3.) Head of greenish-brown mottled stone, with large upturned snout, very small eyes, and large prominent teeth. Height 4.4 cm., breadth 6.2 cm. (Cat. No. $\frac{2939}{256}$.)

(*d*) (Pl. XXVI, Fig. 4.) Small head with upturned nose. Height 5.4 cm., breadth 9.9 cm. (Nat. Mus. of Costa Rica, No. 8922.)

(*e*) (Pl. XXVI, Fig. 5.) Head of opaque white gypsum. It has a fantastic shape, nose protruding, skull provided with a small cap with narrow cylindrical top. Height 7.5 cm., breadth 5.5 cm., diameter of central perforation 2.8 cm. (Cat. No. $\frac{2431}{255}$.)

(*f*) (Pl. XXVI, Fig. 7.) Head of whitish quartz, round in shape, resembling that of an animal like a cat. The eyes are formed of two borings, the first with a hollow cylindrical drill, and afterwards with a solid drill, which has left a conical pit serving as the pupil. The mouth is represented by a row of three circular pits, the walls left standing to form the teeth. Height 5.5 cm., breadth 5.7 cm. (Cat. No. $\frac{2939}{222}$.)

(*g*) (Pl. XXVI, Fig. 8.) Head of grayish-white stone, representing a monster with mouth wide open. This specimen very plainly illustrates the application of the hollow drill. Height 8.2 cm., breadth 6.3 cm. (Nat. Mus. of Costa Rica, No. 9092.)

(*h*) (Fig. 68.) Head of fantastic monster. Both eyes and ears are represented by cylindrical knobs. The former are placed very high up on the front, as is the nose also. The wide open mouth is formed in a peculiar manner by two vertical rows each composed of three hollow drill-holes with the wall in the center left standing. The six cylindrical cores are not removed from the base, but cut off at

the length of about 0.3 cm., serving for the teeth. The material is gray quartz traversed with white streaks. Height 7.8 cm., breadth 5.4 cm.

(*i*) (Fig. 69.) Head of fantastic monster of white stone, with mouth wide open

FIG. 68. Head of monster. (Cat. No. $\frac{2939}{217}$.) $\frac{1}{1}$.

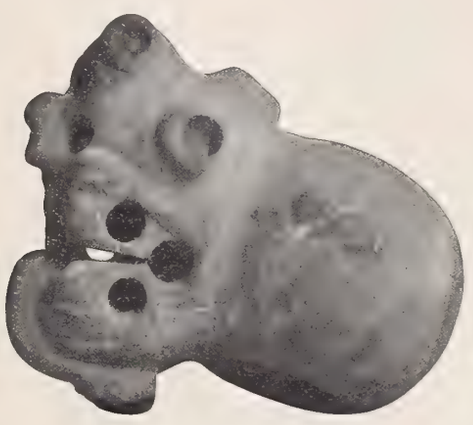


FIG. 69. Head of monster. $\frac{1}{2}$.

and tongue protruding, extending under the jaw. Height 9.6 cm., length 12 cm. (Nat. Mus. of Costa Rica, No. 9031.)

3. *Bird-heads.*

These clubs all represent heads of parrots or owls, the former being by far the most numerous. There are many specimens showing the features of these two birds combined.

(*a*) (Pl. XXVII, Fig. 1.) Head of parrot of white quartz with crest. Height 6.7 cm., breadth 5 cm. (Cat. No. $\frac{2939}{232}$.)

(*b*) (Pl. XXVII, Fig. 2.) Head of owl of gray sandstone, with two head tufts. Height 6 cm., breadth 7.5 cm. (Cat. No. $\frac{2939}{227}$.)

(*c*) (Pl. XXVII, Fig. 3.) Head of owl (?) of white gypsum. Height 6 cm., breadth 8.2 cm. (Cat. No. $\frac{2939}{229}$.)

(*d*) (Pl. XXVII, Fig. 4.) Head of parrot made of greenish bowenite, with two tufts. Height 5.5 cm., breadth 5.5 cm. (Cat. No. $\frac{2438}{261}$.)

(*e*) (Pl. XXVII, Fig. 5.) Head of owl of gray sandstone. Height 6 cm., breadth 7.5 cm. (Cat. No. $\frac{2939}{230}$.)

(*f*) (Pl. XXVII, Fig. 6.) Head of owl (?) of white quartz. Height 6.4 cm., breadth 6.4 cm. (Cat. No. $\frac{2939}{234}$.)

4. *Birds.*

In the clubs of this class, thus far observed by me in the collections from Las Guacas only parrots are represented.

(*a*) (Pl. XXVIII, Fig. 1.) Parrot of gray stone. The beak is perforated with a circular hole. Height 6.7 cm., length 15.1 cm. (Cat. No. $\frac{2438}{260}$.)

(*b*) (Pl. XXVIII, Fig. 2.) Parrot of gray stone with large crest. Height 6.1 cm., length 14.7 cm. (Cat. No. $\frac{2939}{246}$.)

(*c*) (Pl. XXVIII, Figs. 3–4.) Parrot of gray stone. Height 8 cm., length 17.3 cm. (Cat. No. $\frac{2939}{245}$.)

(*d*) (Pl. XXVIII, Fig. 5.) Parrot of gray stone with unusually small beak. Apparently this specimen has had the beak and crest broken off, whereupon a diminutive beak was carved upon the specimen in an unusual position on the lower part of the head. Height 6.7 cm., length 14.3 cm. (Cat. No. $\frac{2939}{247}$.)

(*e*) (Pl. XXVIII, Fig. 6.) Parrot of brown, white-spotted stone. Behind the wings the body is encircled with a band with criss-cross markings. Below each wing there is a cross-mark. Height 7.2 cm., length 17 cm. (Cat. No. $\frac{2438}{274}$.)

(*f*) (Pl. XXIX, Fig. 5.) Parrot of brown stone. This object presumably owes its peculiar shape to some mishap. The broken head has been renewed and provided with a shortened beak and the object has been turned upside down, the two wings now serving as legs. Height 6.5 cm., length 10.3 cm. (Nat. Mus. of Costa Rica, No. 8936.)

5. *Two-legged monsters.*

Only a few specimens of these strange creatures having two legs, large heads, and cone-shaped tails have been found. Like the parrot last described they presumably owe their existence to mishaps. The beak of the winged birds having been broken off, the artist instead of abandoning the object, has transformed it into one of these beings by turning it upside down, using the wings as legs and sculpturing the features of a fantastic animal face on the flattened surface of the head. The legs of these creatures differ in nothing but the position from the bird-wings and even retain the feather marks.

(*a*) (Pl. XXIX, Fig. 1.) Animal figure of gray stone, with highly conventionalized head with strange features. Height 8.4 cm., length 12.3 cm. (Cat. No. $\frac{2939}{251}$.)

(*b*) Pl. XXIX, Fig. 2.) Animal of gray stone with almost square head, broken. Height 5 cm., length 9 cm. (Cat. No. $\frac{2939}{250}$.)

(*c*) Pl. XXIX, Fig. 3.) Animal of brown, white-spotted stone; head square; face flat, with four circular drill marks for eyes and nostrils. Height 7.4 cm., length 11.5 cm. (Cat. No. $\frac{2939}{252}$.)

(*d*) (Pl. XXIX, Fig. 4.) Animal of gray stone resembling the last. Height 6.4 cm., length 10.3 cm. (Cat. No. $\frac{2939}{248}$.)

(*e*) (Pl. XXIX, Fig. 6.) Animal of brown stone having a head with strange features. Height 6.4 cm., length 10.2 cm. (Cat. No. $\frac{2939}{249}$.)

6. *Alligators.*

(*a*) (Pl. XXX, Figs. 1–2.) Alligator of grayish-white stone with nose curved and a herring-bone design along the frontal bone. The ears are represented by cylindrical knobs, which are encircled by grooves, and may have served for securing the club to the handle. The pike-shaped tail is adorned with converging grooves. Length 15.4 cm., breadth 7.4 cm. (Nat. Mus. of Costa Rica, No. 8937.)

(*b*) (Pl. XXX, Fig. 3.) Alligator of white stone with broad greenish streaks. The thick heavy nose is turned up and adorned with a herring-bone design. The truncated tail is also turned upwards and adorned with two herring-bone designs, the one on the top transverse, the other on the under side longitudinal. Length 9.2 cm., breadth 7.3 cm. (Cat. No. $\frac{2939}{255}$.)

(*c*) (Pl. XXX, Fig. 4.) Alligator of white stone with ear knobs. Tail without ornamentation. Length 17.7 cm., breadth 7.6 cm. (Nat. Mus. of Costa Rica, No. 8942.)

(*d*) (Pl. XXX, Fig. 5.) Alligator of grayish white stone with slightly curved nose and a herring-bone design on the frontal bone. The pike-shaped tail is adorned with converging grooves. Length 13.6 cm., breadth 6.8 cm. (Cat. No. $\frac{2939}{253}$.)

(*e*) (Pl. XXX, Fig. 6.) Alligator of white stone with conical ear knobs. Length 19 cm., breadth 9 cm. (Nat. Mus. of Costa Rica, No. 8933.)

(*f*) (Pl. XXVI, Fig. 6.) Alligator of gray stone. Length 13.8 cm., breadth 9 cm. (Nat. Mus. of Costa Rica, No. 8927.)

(*g*) (Pl. XXVI, Fig. 9.) Alligator (?), highly conventionalized. Height 4.4 cm., length 10.6 cm. (Cat. No. $\frac{2939}{258}$.)

7. *Clubs Without Any Zoömorphic Characters.*

These are comparatively few in number and do not vary much in form. The following are the commonest types.

(*a*) (Pl. XXXI, Fig. 1.) Club-head, ring-shaped, and having four cone-shaped protuberances, each of which is adorned with three encircling incisions. Height 4.4 cm., diameter 8.7 cm. (Nat. Mus. of Costa Rica, No. 3319.)

(*b*) (Pl. XXXI, Fig. 2.) Club-head of basaltic lava, star-shaped, having nine points. Diameter 10.2 cm., thickness 3 cm. (Nat. Mus. of Costa Rica, No. 7564.)

(*c*) (Pl. XXXI, Fig. 3.) Club-head of basaltic lava, cylindrical, having four encircling rows of cone-shaped protuberances. Height 5.7 cm., diameter 8.4 cm. (Nat. Mus. of Costa Rica, No. 7708.)

(*d*) (Pl. XXXI, Fig. 4.) Club-head of white-spotted brown stone, ring-shaped, and provided with an encircling incision near the top. Height 4.6 cm., diameter 7 cm. (Cat. No. $\frac{2438}{264}$.)

(*e*) (Pl. XXXI, Fig. 5.) Club-head of gray serpentine (?), ring-shaped. Height 4. cm., diameter 7.4 cm. (Cat. No. $\frac{2438}{271}$.)

(*f*) (Pl. XXXI, Fig. 6.) Club-head, ring-shaped. Height 5.1 cm., diameter 8 cm. (Nat. Mus. of Costa Rica, No. 8946.)

(*g*) (Pl. XXXI, Fig. 7.) Club-head, ring-shaped, of brownish stone. Height 2.8 cm., diameter 6.3 cm. (Cat. No. $\frac{2939}{243}$.)

(*h*) (Pl. XXXI, Fig. 8.) Club-head, ring-shaped, of gypsum. Height 2.9 cm., diameter 6.5 cm. (Cat. No. $\frac{2438}{270}$.)

(*i*) (Pl. XXXI, Fig. 9.) Club-head, ring-shaped, of basaltic lava. Height 3.1 cm., diameter 7.1 cm. (Cat. No. $\frac{2438}{273}$.)

h. Amulets.

Under this term are included a large number of small, polished, ornamental stones of various shapes and colors, all pierced by holes, indicating that they were worn suspended on the body. As is well known, and is fully shown by the Maya and Mexican codices, monuments, and antiquities, it was the custom of the natives of Central America and Mexico to carry artistically sculptured stones as amulets or fetishes for protection against diseases or other evil influences.

In the writings of the early Spanish historians much valuable information is given about the use of ornaments or amulets of precious stones amongst the ancient Mexicans. A resumé of the subject has been given by Squier,[17] which is here reproduced in its essentials.

"Amongst the articles of ornament used by the aboriginal inhabitants of Mexico and Central America, those worked from some variety of green stone resembling emerald, and called by the Nahuatl or Mexican name *chalchiuitl*, *chalchihuite*, or *chalchiuite*, were most highly esteemed, and oftenest mentioned by the early explorers and chroniclers. The word *chalchiuitl* is defined by Molina, in his 'Vocabulario Mexicana' (1571), to signify 'esmeralda baja,' or an inferior kind of emerald. The precious emerald, or emerald proper, was called quetzalitztli, from the *quetzal*, the bird known to science as *Trogon resplendens* (the plumes of which, of brilliant metal-

[17] Squier, E. G. "Observations on a Collection of Chalchiuitls from Mexico and Central America." From the *Annals of the Lyceum of Natural History of New York*, 1869. Reproduced in the *American Naturalist*, Salem, Mass., 1871, p. 171.

lic green, were worn by the kings of Mexico and Central America as regal insignia), and *itzli*, stone, *i. e.*, the stone of the quetzal.

"Sahagun mentions four of the Mexican gods who were the especial patrons of the lapidaries, and honored as the inventors of the art 'of working stones and chalchiuites, and of drilling and polishing them.' He does not, however, describe the process made use of by the Indians in cutting precious stones, 'because,' he says, 'it is so common and well understood'; an omission which his editor, Bustamente, regrets, 'since the art is now entirely lost.'

"Quetzalcoatl, the lawgiver, high-priest, and instructor of the Mexicans in the arts, is said to have taught not only the working of metals, but 'particularly the art of cutting precious stones, such as chalchiuites, which are green stones, much esteemed, and of great value.' (Torquemada, lib. VI, cap. XXIV.) Quetzalcoatl himself according to certain traditions was begotten by one of these stones, which the goddess Chimalma had placed in her bosom. Indeed both among the Mexicans and the nations farther to the southward the chalchihuitl seems to have represented everything that was excellent in its kind. Its name was used in compounding designations of distinction and honor, and was applied both to heroes and divinities. The goddess of water bore the name *Chalchiuitlcuye*, the woman of the Chalchiuites; and the name of *Chalchiuhapan* was often applied to the city of Tlaxcalla, from a beautiful fountain of water near it, the color of which, according to Torquemada, 'was between blue and green.' Cortez, according to the same authority, was often called 'Chalchiuitl,' which is the same as captain of great valor, because chalchiuitl is the color of emerald, and the emeralds are held in high estimation among the nations. (Monarchia Indiana, Vol. I, p. 435.) When a great dignitary died his corpse was richly decorated for burial with gold and plumes of feathers, and 'they put in his mouth a fine stone resembling emerald, which they call chalchihuitl, and which, they say, they place as a heart.' (Ib., Vol. II, p. 521.)

"Sahagun, in one place describes the chalchihuitl as 'a jasper of very green color, or a common emerald.' Elsewhere he goes into a very full description of the various kinds of green stones which the Mexicans held in esteem, and as his account may materially aid in identifying the chalchihuitl, it is subjoined entire:

"'The emerald which the Mexicans call *quetzalitztli* is precious, of great value, and is so called because by the word *quetzalli* they mean to say a very green plume, and by *itztli*, flint. It is smooth, without spot; and these peculiarities belong to the good emerald; namely, it is deep green with a polished surface, without stain, transparent, and at the same time lustrous. There is another kind of stone which is called *quetzalchalchiuitl*, so called because it is very green and resembles the chal-

chiuitl; the best of these are of deep green, transparent, and without spot; those which are of inferior quality have veins and spots intermingled. The Mexicans work these stones into various shapes: some are round and pierced, others long, cylindrical, and pierced; others triangular, hexagonal, or square. There are still other stones called chalchiuites, which are green (but not transparent), mixed with white; they are much used by the chiefs, who wear them fastened to their wrists by cords, as a sign of rank. The lower orders (maceguales) are not allowed to wear them. . . . There is yet another stone called *tlilaiotic*, a kind of chalchuite, in color black and green mixed. And among the jaspers is a variety in color white mixed with green, and for this reason called *iztacchalchiuitl*. Another variety has veins of clear green or blue, with other colors interspersed with the white. . . . And there is yet another kind of green stone which resembles the chalchiuites, and called *xoxouhquitecpatl*. It is known to the lapidaries as *tecelic*, for this reason that it is very easy to work, and has spots of clear blue. The wrought and curious stones which the natives wear attached to their wrists, whether of crystal or other precious stones, they call *chopilotl* — a designation that is given to any stone curiously worked or very beautiful.' The same author, describing the ornaments which the Mexican lords used in their festivals, speaks of 'a head-dress called *quetzalalpitoai*, consisting of two tassels of rich plumes, set in gold, and worn suspended from the hair at the crown of the head, and hanging down on each side towards the shoulders. They also wear rings of gold around the arms and in their ears, and round their wrists a broad band of black leather, and suspended to this a large bead of chalchiuitl or other precious stone. They also wear a chin ornament (barbote) of chalchiuitl set in gold, fixed in the beard. Some of these barbotes are large crystals, with blue feathers put in them, which gives them the appearance of sapphires. There are many other varieties of precious stones which they use for barbotes. They have their lower lips slit, and wear these ornaments in the openings, where they appear as if coming out of the flesh; and they wear in the same way semilunes of gold. The noses of the great lords are also pierced, and in the openings they wear fine turquoises or other precious stones, one on each side. They wear strings of precious stones around their necks, sustaining a gold medal set around with pearls, and having in its center a smooth precious stone.'"

In Porto Rico according to ancient writers, quoted by Dr. J. W. Fewkes in his interesting and instructive essays[18]: "small sculptured stone images were worn about the forehead of the aborigines when they went to battle," but, as Dr. Fewkes presumes, "they were probably worn also on other parts of the body."

[18] Fewkes, J. W. "Precolumbian West Indian Amulets." *American Anthropologist*, N. S., 1903, Vol. 5, p. 679.

The only source of information as to the manner in which amulets were worn by the natives of Nicoya is found in the representations of human figures on objects of clay or stone from the burial-grounds. Only a very small number of these human effigies, however, are thus adorned. There are some clay figures from various localities near the pueblo of Nicoya which have necklaces and on the breast a pendant.

The use of large round ear-ornaments is also illustrated by figures of clay.

Of all the objects found in the burial-ground of Las Guacas none are more numerous than the amulets. Several thousand specimens have been unearthed. The commonest are those which have the shape of a celt or a grooved axe, which has been divided lengthwise, the convex side serving as the front.

As a rule the specimens of various forms of amulets show at most only insignificant signs of wear, proving that they were strung and fastened in such a way that hardly any wear could take place. The absence of signs of wear is also explained by the facts that the amulets were mostly made of very hard stones and were not used for more than one generation, being apparently always interred with the owner at his death.

The following classification has been adopted for the supposed amulets and other small objects of stone which were worn on the body or dress:

1. CELT-SHAPED AMULETS.
   - A. *Worn in vertical position.*
     - (*a*) Designs anthropomorphic.
     - (*b*) Designs ornithomorphic.
     - (*c*) Plain.
   - B. *Worn in horizontal position.*
     - (*a*) Designs of alligators or fishes.
     - (*b*) Plain.
2. FIGURINES SCULPTURED IN THE ROUND.
   - (*a*) Human figurines and heads.
   - (*b*) Mammalian figurines and heads.
   - (*c*) Bird-shaped figurines and heads.
   - (*d*) Various animals of the lower orders.
3. TUBES.
4. BEADS.
5. VARIOUS SMALL OBJECTS WITHOUT ANY BIOMORPHIC FEATURES.

A number of amulets and other small stone ornaments, etc., from Las Guacas are figured on Pls. XXXII–XLV, and short descriptions of them are given in the following pages.

1. *Celt-shaped Amulets.*

Amulets of this form are by far the most numerous at Las Guacas. A large portion of them retain the shape of a divided, typical celt of this locality, the anterior side of these amulets being more or less convex, the posterior flat. Many specimens of this group are provided with a groove at each edge near the upper end and thus take the shape of an ax. Many others are narrow, rectangular, and often very slender. Of these numerous specimens have even the anterior side flat, or nearly so.

Most of the amulets are plain, but a very large number have the front adorned with anthropomorphic or zoömorphic designs, often reduced to simple geometrical patterns. As a rule this ornamentation is limited to the upper half of the front of the amulet, which generally shows only the head and upper portion of the body of a man or bird, while the lower half of the amulet, representing the portion below the abdomen, is plain and usually cut quite thin, forming the "blade" of the tool.

While much effort was expended on sculpturing and polishing these small objects, it is worthy of notice that in many cases very little attention was paid to finishing the back. The central ridge along the back, which was left when the specimen was produced by sawing into the stone from opposite sides and then breaking away the ornamented part from the block, although conspicuously rough, is in many cases retained. In other specimens this ridge was ground down and entirely removed.

The process of making the celt-shaped amulets is plainly illustrated by two pieces of jade found in the burial-ground. Pl. XXXII, Figs. 1, 2, shows an oblong core or block of green stone found by me at Las Guacas, from which amulets had been cut. Along the longer side of this interesting specimen the ridge left after an amulet had been split is seen and on the top an elliptical base of another amulet which had been removed is distinguishable. Pl. XXXII, Figs. 3, 4, shows a large water-worn jade pebble from the Velasco collection. On the side which had been cut flat a ridge running along the middle is left, while on the rounded opposite side a straight groove or saw-cut has been made.

The amulets have holes drilled into them for the cords by which they were suspended. In many specimens, which have been drilled from the face, only a single hole near the upper end is found, in other cases there are two such holes. In most cases only a single hole has been drilled through from the side parallel to the flattened surfaces of the amulet.

Some of the celt-shaped amulets, plain as well as sculptured, were cut in two lengthwise. A few such twice divided specimens are illustrated on Pl. XXXIV, Figs. 10, 11, 12, 17; Pl. XXXVII, Figs. 9, 10, 11, 17; and Pl. XXXVIII, Figs. 4, 5.

This was observed long ago by Professor F. W. Putnam in the case of celt-shaped amulets from Nicaragua, and is referred to by Mrs. Zelia Nuttall[19], who says: "In the Peabody Museum there are several specimens of jade celts collected by Dr. Earl Flint in Nicaragua which have been cut into two or more pieces. Professor Putnam had the satisfaction of discovering that these pieces from different graves fitted together. His inference is that the stones must have been rare and highly prized, probably from some motive connected with native ritual."

Although celt-shaped stone amulets have been found in various localities on the American continent, it seems that the aborigines nowhere else used this symbolic object so extensively as in Nicoya.

A. *Celts Worn in a Vertical Position.*

a. *Anthropomorphic Celt-shaped Amulets.*

These are by far the most numerous of the sculptured celts. Roughly estimated about three times as many have been found of this class as of the zöomorphic.

The human figure of the celts, except in a comparatively few specimens, is represented with the head 'en face' and with the arms and upper half of the body delineated. The head is disproportionately large, and, being usually adorned with a head-dress, occupies a considerable portion of the upper half of the celt. Often the lower part of the face, including the nose, is represented enclosed by a square incision, having its upper corner at the root of the nose, its opposite at the apex of the chin. The eyes are always placed outside of the 'face square' on a line with its upper corner. The chin is in numerous specimens triangular, beak-shaped, prolonged downwardly on the breast. The nose is conspicuously broad, as is also the mouth, which is formed by from one to two or three parallel, horizontal grooves. Each of the corners of the mouth is frequently indicated by a small circular pit. Only very rarely are the teeth delineated by the artist as in Pl. XXXIII, Fig. 2, where in both jaws they are plainly figured, or in Pl. XXXIII, Fig. 9, where they are crudely indicated by a row of short, parallel, vertically placed incisions. The tongue of some of the figures, as those represented on Pl. XXXIII, Fig. 1, and Pl. XXXV, Fig. 6, is shown protruding, and in Pl. XXXIV, Fig. 13, it is also prolonged.

For sculpturing the eye various methods have been chosen by the artist. The commonest mode, as illustrated by Pl. XXXIII, Fig. 1, and Pl. XXXIV, Figs. 1, 3, 4, is simply by making use of two circular drilled pits. A peculiar feature is that

[19] Nuttall, Zelia: "The Fundamental Principles of Old and New World Civilizations." Peabody Museum, Cambridge, Mass., 1901, pp. 195–196.

the eye-pits are often united by a linear transverse groove, as in Pl. XXXIII, Figs. 9 and 12, and Pl. XXXIII, Fig. 6. In Pl. XXXIII, Figs. 4 and 5, two circular rings are made with a hollow drill and the core-marks serve as the pupils. In Pl. XXXIII, Figs. 6, 7, and 10, and Pl. XXXIV, Figs. 19 and 20, each of the eyes is formed simply by one to three short, parallel, horizontal grooves, and in Pl. XXXIII, Fig. 3, and Pl. XXXIV, Fig. 5, the pupil is added by means of a circular hole drilled in the center of the groove. Pl. XXXIV, Fig. 2, shows one of the few faces with the curved eyebrows plainly marked.

Most of the figures have the front of the head adorned with a decorated band for keeping up the hair, or they have an elaborate head-dress. The hair-band is prevalently decorated with a herring-bone or criss-cross design. The head-dress usually takes the shape of two opposing more or less conventionalized animal (alligator) heads seen in profile, the body being common. On the celts brought together on Pl. XXXIV, Figs. 1 to 9, the gradual transformation of the two animal heads into two insignificant knobs is demonstrated. Compare also on Pl. XXXVIII the representations of the alligators with their characteristic upturned noses.

Regarding the position of the arms it may be observed that, while the arms from the shoulder to the elbow are always represented as placed parallel to the body, the fore-arms are represented as horizontal, either with the hands meeting on the abdomen or one placed a little above the other, in such a manner that the right hand is seen on the left side and vice versa. In the latter case Dr. Fischer in the work on Costa Rican stone implements above quoted infers that the attitude indicates the peculiar way of reverentially bowing which is customary among certain peoples. Only rarely do the arms cross each other on the breast as in Pl. XXXIII, Fig. 17, Pl. XXXV, Fig. 16, and Pl. XLIII, Fig. 2. In a few cases, as in Pl. XXXIII, Figs. 10 and 12, and Pl. XXXV, Fig. 12, the forearms are held against the breast, and in Pl. XXXIII, Figs. 11 and 13, and Pl. XXXIV, Fig. 8, they are stretched up toward the armpits. In Pl. XXXIII, Fig. 15, there is one of the few exceptional cases representing a man holding the right hand up against the breast, and XXXIII, Figs. 14 and 16, show figures holding the left hand in the same position. In Pl. XXXV, Fig. 13, the almost monkey-like figure seems to grasp some small object in each hand. The fingers are always indicated by straight parallel incised lines. The nipples of the breast are very seldom marked, as is the case in Pl. XXXIII, Fig. 4. None of the figures have the sex indicated.

A circular amulet or ornament for the breast is shown in Fig. 5, on Pl. XXXIII, and a necklace adorns Fig. 6 on the same plate.

There is a small group of anthropomorphic celts upon which are sculptured not

merely the upper half of the human body, but the entire figure. In these specimens, which show the head and arms free and sometimes the legs also, the original outlines of the celt have more or less disappeared. A number of similar partly transformed celts are shown on Pl. XXXV.

In a few cases the anthropomorphic celt is almost triangular in shape, as in Pl. XXXIV, Fig. 18.

The anthropomorphic celts pass over into those of the following group, the ornithomorphic, by a series of intermediate forms, and strict lines can hardly be drawn between the two groups. The head of a bird, when borne by the human figure, undoubtedly represents a mask worn in certain ceremonies. In ancient Mexico it will be recalled that warriors are mentioned as distinguished by wearing bird-masks.

A number of anthropomorphic celts are illustrated on Pls. XXXIII–XXXV:

Celt of gray stone; a human figure with large head-dress and lip ornament. Arms placed horizontally across the breast, the right arm above the left. Length 23.1 cm., breadth 7.1 cm. Pl. XXXIII, Fig. 1. (Cat. No. $\frac{2939}{315}$.)

Celt of granulite (?); a human figure with large head-dress. Arms as in the above, the right arm above the left. Length 20.5 cm., breadth 6.5 cm. Pl. XXXIII, Fig. 2. (Cat. No. ($\frac{2939}{260}$.)

Celt of serpentine; a human figure, with the hands meeting on the abdomen. Length 19.1 cm., breadth 5.9 cm. Pl. XXXIII, Fig. 3. (Cat. No. $\frac{2939}{263}$.)

Celt of serpentine (?); a human figure, the left arm above the right resting on the abdomen. Breasts (?) indicated through pair of circular marks. Length 19.8 cm., breadth 3.4 cm. Pl. XXXIII, Fig. 4. (Cat. No. $\frac{2939}{320}$.)

Celt of serpentine; a human figure with an amulet on the breast. Hands meeting on the abdomen. Length 12.9 cm., breadth 4 cm. Plate XXXIII, Fig. 5. (Nat. Mus. of Costa Rica, No. 7851.)

Celt of serpentine; a human figure adorned with a necklace. Hands meeting on the abdomen. Length 11.8 cm., breadth 3.2 cm. Pl. XXXIII, Fig. 6. (Cat. No. $\frac{2939}{344}$.)

Celt of Serpentine; a human figure; arms over the abdomen not very plainly marked. Length 9.7 cm., breadth 3.3 cm. Pl. XXXIII, Fig. 7. (Cat. No. $\frac{2939}{484}$.)

Celt of pale-green bowenite; human figure; arms omitted. Length 7.1 cm. breadth 3.3 cm. Pl. XXXIII, Fig. 8. (Cat. No. $\frac{2438}{332}$.)

Celt of pale-green bowenite; human figure; arms laid across the breast horizontally; teeth marked. Length 9.1 cm., breadth 5.8 cm. Pl. XXXIII, Fig. 9. (Cat. No. $\frac{2438}{320}$.)

Celt of serpentine; human figure; both arms held up against the breast. Length 12.8 cm., breadth 3 cm. Pl. XXXIII, Fig. 10. (Cat. No. $\frac{2939}{324}$.)

Celt of green stone; human figure; arms bent straight up towards the shoulders. Length 12.5 cm., breadth 3 cm. Pl. XXXIII, Fig. 11. (Nat. Mus. of Costa Rica, No. 7805.)

Celt of serpentine; human figure; arms held up against the breast. Length 13.2 cm., breadth 4.2 cm. Pl. XXXIII, Fig. 12. (Cat. No. $\frac{2939}{268}$.)

Celt of serpentine; human figure; arms flexed toward the shoulders. Length 9 cm., breadth 1.9 cm. Pl. XXXIII, Fig. 13. (Cat. No. $\frac{2939}{355}$.)

Celt of serpentine; human figure; right arm flexed against the breast, the left resting on the abdomen. Length 14.3 cm., breadth 3.8 cm. Pl. XXXIII, Fig. 14. (Cat. No. $\frac{2939}{322}$.)

Celt of gypsum; human figure; left arm against the breast; the right arm over the abdomen. Length 15 cm., breadth 3 cm. Pl. XXXIII, Fig. 15. (Cat. No. $\frac{2939}{323}$.)

Celt of gypsum; human figure; right arm held against the breast, the left arm over the abdomen. Length 10.1 cm., breadth 3.4 cm. Pl. XXXIII, Fig. 16. From Hartman's excavations at Las Guacas. (Cat. No. $\frac{2793}{128}$.)

Celt of green stone; human figure; arms crossing the breast. Length 8.5 cm., breadth 3.4 cm. Pl. XXXIII, Fig. 17. (Nat. Mus. of Costa Rica, No. 7731.)

Celt of serpentine; human figure, adorned with head-dress. Length 18.9 cm., breadth 3.2 cm. Pl. XXXIV, Fig. 1. (Cat. No. $\frac{2438}{278}$.)

Celt of gray stone; human figure, adorned with head-dress. Length 15.8 cm., breadth 2.6 cm. Pl. XXXIV, Fig. 2. (Cat. No, $\frac{2428}{281}$.)

Celt of black nephrite; human figure, adorned with head-dress. Length 13.2 cm., breadth 2.6 cm. Pl. XXXIV, Fig. 3. (Cat. No. $\frac{2939}{314}$.)

Celt of grey stone; human figure adorned with head-dress. Length 12 cm., breadth 4.1 cm. Pl. XXXIV, Fig. 4. (Cat. No. $\frac{2438}{294}$.)

Celt of gypsum; human figure, adorned with head-dress. Length 10.2 cm., breadth 3.9 cm. Pl. XXXIV, Fig. 5. (Cat. No. $\frac{2438}{295}$.)

Celt of euphrotide; human figure, adorned with head-dress. Length 8.8 cm., breadth 3.3 cm. Pl. XXXIV, Fig. 6. (Cat. No. $\frac{2438}{296}$).

Celt of gray stone; human figure, adorned with head-dress. Length 10 cm., breadth 3.5 cm. Pl. XXXIV, Fig. 7. (Cat. No. $\frac{2936}{349}$.)

Celt of greenish bowenite; human figure, adorned with head-dress. Length 10.8 cm., breadth 4.6 cm. Pl. XXXIV, Fig. 8. (Cat. No. $\frac{2939}{276}$.)

Celt of green jade; human figure. The specimen is cut in two from the front

longitudinally, thus quartered. Length 17.4 cm., breadth 2.2 cm. Pl. XXXIV, Fig. 10. (Cat. No. $\frac{2939}{410}$.)

Celt of green jade; human figure. The specimen is cut in two from the front longitudinally. Length 16.1 cm., breadth 2 cm. Pl. XXXIV, Fig. 11. (Cat. No. $\frac{2939}{411}$.)

Celt of blackish stone; human figure with extended tongue (?). Length 11.8 cm., breadth 4.6 cm. Pl. XXXIV, Fig. 13. (Cat. No. $\frac{2939}{277}$.)

Celt of gray stone; human figure, highly conventionalized, with large headdress. Compare Figs. 1–9 of same plate. Length 6.2 cm., breadth 2.8 cm. Pl. XXXIV, Fig. 15. (Nat. Mus. of Costa Rica, No. 7953.)

Celt of serpentine, plain, with three parallel transverse incised lines near the top. Length 8.5 cm., breadth 4.6 cm. Pl. XXXIV, Fig. 16. (Cat. No. $\frac{3959}{660}$.)

Celt of light green jade, plain, with three parallel transverse incised lines near the top. Length 11.9 cm., breadth 1.6 cm. Pl. XXXIV, Fig. 17. (Cat. No. $\frac{2939}{659}$.)

Celt of grayish stone of rather unusual triangular shape; human figure. Length 10.2 cm., breadth 4.9 cm. Pl. XXXIV, Fig. 18. (Cat. No. $\frac{2438}{368}$.)

Celt of white felsite; human figure. Length 11.2 cm., breadth 2.3 cm. Pl. XXXIV, Fig. 19. (Cat. No. $\frac{2939}{398}$.)

Celt of felsite; human figure. Length 14.7 cm., breadth 2.9 cm. Pl. XXXIV, Fig. 20. (Cat. No. $\frac{2438}{283}$.)

Celt of green bowenite, plain, with a criss-cross banded head ornament near the top. Length 9.9 cm., breadth 3.8 cm. Pl. XXXIV, Fig. 21. (Cat. No. $\frac{2438}{475}$.)

Celt of green jade representing a bear or a human figure. Length 6 cm., breadth 2.7 cm. Pl. XXXV, Fig. 1. (Cat. No. $\frac{2939}{407}$.)

Celt of serpentine; human figure. Length 5.9 cm., breadth 3 cm. Pl. XXXV, Fig. 2. (Cat. No. $\frac{2939}{400}$.)

Celt of gray stone representing a bear or a human figure. Length 6 cm., breadth 2.8 cm. Pl. XXXV, Fig. 3. (Cat. No. $\frac{2939}{405}$.)

Celt of pale green bowenite; human figure. Length 5.6 cm., breadth 1.5 cm. Pl. XXXV, Fig. 4. (Cat. No. $\frac{2939}{404}$.)

Celt of gray stone; human figure. Length 9.9 cm., breadth 3 cm. Pl. XXXV, Fig. 5. (Nat. Mus. of Costa Rica, No. 7831.)

Celt of serpentine; human figure, with tongue thrust out. Length 10.9 cm., breadth 4 cm. Pl. XXXV, Fig. 6. (Cat. No. $\frac{2939}{399}$.)

Human figure of serpentine (?) sculptured in the round. Length 6.1 cm., breadth 2.5 cm. Pl. XXXV, Fig. 7. (Nat. Mus. of Costa Rica, No. 8494.)

Human figure of pale green stone, sculptured in the round. Length 5.8 cm., breadth 3 cm. Pl. XXXV, Fig. 8. (Nat. Mus. of Costa Rica, No. 8489.)

Celt of serpentine (?); human figure highly conventionalized, the head being divided in the middle almost to the same depth as the division between the legs. Length 4.6 cm., breadth 2.5 cm. Pl. XXXV, Fig. 9. (Cat. No. $\frac{2939}{401}$.)

Celt of serpentine (?); human figure, highly conventionalized. Length 9 cm., breadth 2.7 cm. Pl. XXXV, Fig. 10. (Cat. No. $\frac{2939}{1173}$.)

Celt of green bowenite; human figure. Broken. Length 8.7 cm., breadth 2.9 cm. Pl. XXXV, Fig. 11. (Cat. No. $\frac{2939}{414}$.)

Celt of green bowenite (?); human figure with both hands against the chin. Length 9.5 cm., breadth 3.9 cm. Pl. XXXV, Fig. 12. (Cat. No. $\frac{2939}{284}$.)

Celt of green bowenite, simian figure. Length 3.9 cm., breadth 2.9 cm. Pl. XXXV, Fig. 13. (Cat. No. $\frac{2939}{416}$.)

Celt of whitish stone; human figure with three longitudinal slits, two serving for separating the arms from the body, the third possibly for marking the sex. Length 9.7 cm., breadth 4.4 cm. Pl. XXXV, Fig. 14. (Nat. Mus. of Costa Rica, No. 7834.)

Fig. 16. Celt of serpentine (?); human figure with arms crossed on breast, Length 6.7 cm., breadth 2.2 cm. Pl. XXXV, Fig. 16. (Cat. No. $\frac{2939}{311}$.)

Celt of whitish stone; monkey-like figure with broad snout and in sitting position. Length 6.8 cm., breadth 2 cm. Pl. XXXV, Fig. 17. (Nat. Mus. of Costa Rica, No. 8488.)

Celt of green jade; human (?) figure. Length 6.8 cm., breadth 3.1 cm. Pl. XXXV, Fig. 24. (Cat. No. $\frac{2939}{301}$.)

(*b*) *Ornithomorphic Celt-shaped Amulets.*

This group, although well represented in numbers at Las Guacas, is comparatively smaller than the former. Only parrots, and in a smaller number of instances owls, appear to be embodied in the celt-shaped amulets. As is the case with the bird-shaped banner-stones, intermediate forms occur here also.

Bird-celts may be arranged in two large groups, according to their general shape. The first group resembles in general shape the common type of anthropomorphic celts, being apparently parted, rather thin, with the upper half of the front slightly convex, the lower half flat, the back also flat, usually with the ridge left in cutting still remaining and not polished away. Typical specimens are illustrated on Pl. XXXV, Figs. 19, 20, 21, and 25. In the second and largest group, apparently no partition of the original celt has taken place, the whole back being more or less con-

vex, while the convex upper half of the front shows in high relief the head and wings of the bird, and the lower half is cut flat and thin and is devoid of ornamentation. (Compare the figures on Pl. XXXVI.) The latter type in many specimens takes the form of a grooved ax, the head of the bird serving as the head of the ax, the neck representing the grooved part, and the lower half of the body forming the blade, which often broadens out toward the edge. In the more highly conventionalized forms of similar celts the bird-like features gradually disappear. In a number of these small amulets all avian features have been dropped, and only a plain grooved ax is left. Pl. XXXVI shows a number of the transitional forms. The crests and ear-tufts of the bird are generally emphasized by the artist. An incised band at the front of the head, similar to the head-band of the human figure, is frequently seen, and some birds are adorned with high head-dresses resembling those on the anthropomorphic celts. In some figures, as those represented on Pl. XXXV, Figs. 19, 21, 22, and 25, the feathers of the wings are delineated, and a few specimens, as those on Pl. XXXV, Figs. 21 and 25, even show the legs and the feet. As most of the bird-celts are more or less convex and rather thick, the hole for suspension is nearly always drilled from the side; only in a few very thin specimens which could not be pierced in this way, are two circular holes drilled in from the front.

In a certain portion of the ornithomorphic celts (only rarely in the anthropomorphic), the figure, instead of appearing as seen 'en face' is sculptured in profile, with the head cut out usually on the left, but in some cases on the right side. On Pl. XXXVII are shown a number of specimens of the latter class, ranging from examples in which all the details of the body are brought out to such as represent the most conventionalized and simplified forms. Two similar figures are also shown on Pl. XLIV, Figs. 2 and 4.

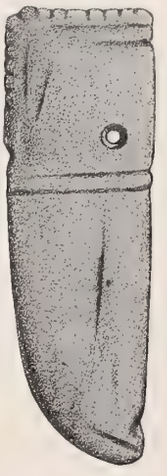


FIG. 70. Bird-shaped celt, wrongly identified as a whale by Dr. H. Fischer.

The zoölogical identification of conventionalized animal forms is often a puzzling task, particularly when the investigator does not have at his disposition large series of all the animal forms represented in art by the people or culture under study. Even then it frequently is impossible in certain cases to make exact determinations, owing to the fact that in art different animals have been given purely fantastic characters, and hybrid forms of animals, or of man with animals occur. To draw conclusions from a small number of specimens in consequence becomes a risky undertaking. A wide field for speculation is always open to the student who tries such an experiment. In Dr.

H. Fischer's work on Costa Rican artefacts of stone, referred to above, one of the ornithomorphic celts, reproduced in Fig. 70 and representing a highly conventionalized parrot, or other crested bird, (Compare Pl. XXXVII, and Pl. I, Fig. 6), has been placed in an horizontal position, and then identified as that of a whale.

A number of ornithomorphic celts are briefly described in the following paragraphs:

Bird-like celt of dark green bowenite. Length 10.4 cm., breadth 2.6 cm. Pl. XXXV, Fig. 15. (Cat. No. $\frac{2939}{300}$.)

Celt having the shape of a parrot, made of serpentine, sculptured in the round. Length 6 cm., breadth 2.2 cm. Pl. XXXV, Fig. 18. (Cat. No. $\frac{2939}{575}$.)

Ornithomorphic celt of unusual form, made of quartz (?). Length 5.1 cm., breadth 3.3 cm. Pl. XXXV, Fig. 19. Cat. No. $\frac{2438}{450}$.)

Celt made of bowenite, having the figure of a bird, adorned with a necklace. Length 5.2 cm., breadth 1.8 cm. Pl. XXXV, Fig. 20. (Cat. No. $\frac{2939}{553}$.)

Bird-like celt of gray stone. Length 12.7 cm., breadth 4.1 cm. Pl. XXXV, Fig. 21. (Cat. No. $\frac{2939}{442}$.)

Bird-like celt of serpentine. Length 5.5 cm., breadth 2.4 cm. Pl. XXXV, Fig. 22. (Cat. No. $\frac{2939}{576}$.)

Bird-like celt of bluish-green jade. Length 5.5 cm., breadth 2.3 cm. Pl. XXXV, Fig. 23. (Cat. No. $\frac{2939}{555}$.)

Celt of bluish-green jade (?) having the form of a bird. Length 7.3 cm., breadth 3.8 cm. Pl. XXXV, Fig. 25. (Cat. No. $\frac{2939}{532}$.)

Celt of white felsite, parrot-like, with two heads, one above the other. Length 14.9 cm., breadth 3 cm. Pl. XXXVI, Fig. 1 (side view); Fig. 2 (front view). (Cat. No. $\frac{2939}{440}$.)

Celt of quartz (?), parrot-like. Length 15 cm., breadth 5 cm. Pl. XXXVI, Fig. 3. (Cat. No. $\frac{2939}{441}$.)

Celt of dark-green mottled jade, parrot-like. Length 14.8 cm., breadth 3.2 cm. Pl. XXXVI, Fig. 4. (Nat. Mus. of Costa Rica, No. 7853.)

Celt of serpentine possibly representing an owl. Length 6.6 cm., breadth 3.2 cm. Pl. XXXVI, Fig. 5. (Cat. No. $\frac{2929}{453}$.)

Bird-like celt of green bowenite. Length 14.9 cm., breadth 2.6 cm. Pl. XXXVI, Fig. 6. (Cat. No. $\frac{3438}{440}$.)

Celt of serpentine, bird-like, double-headed, conventionalized. Length 14 cm., breadth 2.4 cm. Pl. XXXVI, Fig. 7. (Cat. No. $\frac{2438}{441}$.)

Bird-like celt of light green mottled jade (parrot). Length 12.2 cm., breadth 2.4 cm. Pl. XXXVI, Fig. 8. (Nat. Mus. of Costa Rica, No. 7745.)

Bird-like celt of serpentine, conventionalized. Length 11.4 cm., breadth 1.8 cm. Pl. XXXVI, Fig. 9. (Cat. No. $\frac{2939}{458}$.)

Bird-like celt of gypsum (owl). Length 12.5 cm., breadth 3.7 cm. Pl. XXXVI, Fig. 10. (Cat. No. $\frac{2438}{404}$.)

Celt of whitish stone representing an owl. Length 10 cm., breadth 4 cm. Pl. XXXVI, Fig. 11. (Nat. Mus. of Costa Rica, No. 3329.)

Celt of grayish stone, representing an owl. Compare ornamentation of head with Pl. XXXIV, Figs. 1–8. Length 9.4 cm., breadth 3.8 cm. Pl. XXXVI, Fig. 12. (Nat. Mus. of Costa Rica, No. 7826.)

Owl-like celt of white stone. Compare ornament of head with Pl. XXXIV, Figs. 1–8. Length 7.8 cm., breadth 2.8 cm. Pl. XXXVI, Fig. 13. (Nat. Mus. of Costa Rica, No. 10679.)

Owl-like celt of blackish-green jade. Length 5.5 cm., breadth 3.1 cm. Pl. XXXVI, Fig. 14. (Nat. Mus. of Costa Rica, No. 7817.)

Celt of serpentine. Length 11.3 cm., breadth 4 cm. Pl. XXXVI, Fig. 15. (Cat. No. $\frac{2438}{437}$.)

Celt of serpentine (?). Length 10.2 cm., breadth 5.1 cm. Pl. XXXVI, Fig. 16. (Cat. No. $\frac{2939}{448}$.)

Celt of gypsum. Length 10.5 cm., breadth 4.3 cm. Pl. XXXVI, Fig. 17. (Cat. No. $\frac{2438}{436}$.)

Parrot-like celt of gray stone with button-like protuberance on the forehead. Length 9.2 cm., breadth 3.7 cm. Pl. XXXVI, Fig. 18. (Cat. No. $\frac{2939}{446}$.)

Parrot-like celt of stone, conventionalized. Length 9.8 cm., breadth 2.6 cm. Pl. XXXVI, Fig. 19. (Nat Mus. of Costa Rica, No. 7752.)

Bird-like celt of stone, conventionalized. Length 5 cm., breadth 2 cm. Pl. XXXVI, Fig. 20. (Nat. Mus. of Costa Rica.)

Celt of stone, conventionalized bird. Length 10.4 cm., breadth 4.1 cm. Pl. XXXVI, Fig. 21. (Nat. Mus. of Costa Rica.)

Ornithomorphic celt of stone, conventionalized. Length 4.1 cm., breadth 1.7 cm. Pl. XXXVI, Fig. 22. (Nat. Mus. of Costa Rica.)

Ornithomorphic celt of stone, conventionalized. Length 7.1 cm., breadth 5 cm. Pl. XXXVI, Fig. 23. (Nat. Mus. of Costa Rica, No. 8145.)

Ornithomorphic celt of stone, conventionalized. Length 4.6 cm., breadth 2.1 cm. Pl. XXXVI, Fig. 24. (Nat. Mus. of Costa Rica, No. 8170.)

Bird-like celt of serpentine, conventionalized. Length 5.1 cm., breadth 2.1 cm. Pl. XXXVI, Fig. 25. (Cat. No. $\frac{2793}{125}$.)

Ornithomorphic celt of pale green bowenite. Length 11.1 cm., breadth 5.3 cm. Pl. XXXVI, Fig. 26. (Cat. No. $\frac{2438}{435}$.)

Parrot-like celt of green jade. Length 7 cm., breadth 2.1 cm. Pl. XXXVII, Fig. 1. (Cat. No. $\frac{2939}{579}$.)

Bird-like celt of stone (parrot). Length 6.1 cm., breadth 2.2 cm. Pl. XXXVII, Fig. 2. (Nat. Mus. of Costa Rica.)

Parrot-like celt of stone. Length 5 cm., breadth 1.9 cm. Pl. XXXVII, Fig. 3. (Nat. Mus. of Costa Rica.)

Bird-like celt of serpentine. Length 6.3 cm., breadth 1.6 cm. Pl. XXXVII, Fig. 4. (Cat. No, $\frac{2939}{600}$.)

Bird-like celt of serpentine (?). Length 9.8 cm., breadth 2.3 cm. Pl. XXXVII, Fig. 5. (Cat. No. $\frac{2939}{484}$.)

Bird-like celt of gypsum. Length 10.8 cm., breadth 2 cm. Pl. XXXVII, Fig. 6. (Cat. No. $\frac{2939}{615}$.)

Bird-like celt of serpentine. Length 7.4 cm., breadth 1.3 cm. Pl. XXXVII, Fig. 7. (Cat. No. $\frac{2939}{609}$.)

Bird-like celt of gypsum. Length 12.1 cm., breadth 1.9 cm. Pl. XXXVII, Fig. 8. (Cat. No. $\frac{2438}{481}$.)

Highly conventionalized celt of green jade. Length 9.3 cm., breadth 2.1 cm. Pl. XXXVII, Fig. 9. (Cat. No. $\frac{2939}{627}$.)

Celt of serpentine, highly conventionalized bird, with a transverse incision near the upper end. Length 10.7 cm., breadth 1.7 cm. Pl. XXXVII, Fig. 10, (Cat. No. $\frac{2939}{680}$.)

Celt of jade, highly conventionalized bird. Length 8 cm., breadth 2.5 cm. Pl. XXXVII, Fig. 11. (Cat. No. $\frac{2939}{630}$.)

Celt of green jade, conventionalized bird. Length 15 cm., breadth 2.3 cm. Pl. XXXVII, Fig. 20. (Cat. No. $\frac{2939}{593}$.)

Bird-like celt of whitish stone. Length 8.3 cm., breadth 3.4 cm. Pl. XXXVII, Fig. 21. (Cat. No. $\frac{2939}{594}$.)

Bird-like celt of quartz (?). Length 11.7 cm., breadth 2.5 cm. Pl. XXXVII, Fig. 22. (Cat. No. $\frac{2939}{602}$.)

Bird-like celt of green bowenite, ax-shaped, the blade broad with a quadrangular incision on the neck. Length 6.2 cm., breadth 6 cm. Pl. XXXVII, Fig. 22. (Cat. No. $\frac{2438}{476}$.)

(c) *Plain Celt-shaped Amulets.*

These are less numerous than the sculptured. Nearly all the plain amulets have only one hole for suspension. Only some of the very largest as Pl. XXXVII, Fig. 12, are provided with two holes. The following specimens are typical of this group.

Celt of bluish green jade, showing back with the central ridge left in cutting. Length 20.2 cm., breadth 6.9 cm. Pl. XXXVII, Fig. 12. (Cat. No. $\frac{2939}{890}$.)

Celt of greenish granulite, showing back with the central ridge, left in cutting, ground down. Length 15.4 cm., breadth 2.3 cm. Pl. XXXVII, Fig. 13. (Cat. No. $\frac{2939}{900}$.)

Celt of green jade. Length 14.3 cm., breadth 2.3 cm. Pl. XXXVII, Fig. 14. (Cat. No. $\frac{2939}{896}$.)

Celt of quartz (?). Length 7.8 cm., breadth 2.3 cm. Pl. XXXVII, Fig. 15. (Cat. No. $\frac{2939}{763}$.)

Celt of green jade. Length 14.1 cm., breadth 2.5 cm. Pl. XXXVII, Fig. 16. (Cat. No. $\frac{2939}{894}$.)

Celt of mottled greenish stone. Length 7.5 cm., breadth 2 cm. Pl. XXXVII, Fig. 17. (Cat. No. $\frac{2939}{941}$.)

Celt of serpentine. Length 10.5 cm., breadth 3.6 cm. Pl. XXXVII, Fig. 18. (Cat. No. $\frac{2939}{721}$.)

Celt of mottled greenish stone. Length 8.3 cm., breadth 2.1 cm. Pl. XXXVII, Fig. 19. (Cat. No. $\frac{2939}{950}$.)

Celt of serpentine. Length 5.8 cm., breadth 3.1 cm. Pl. XXXVII, Fig. 23. (Cat. No. $\frac{2939}{861}$.)

Celt of serpentine. Length 5.7 cm., breadth 3.4 cm. Pl. XXXVII, Fig. 24. (Cat. No. $\frac{2438}{568}$.)

Celt of whitish green jade cut in two from the front longitudinally. Length 18.2 cm., breadth 3.8 cm. Pl. XXXIV, Fig. 12. (Cat. No. $\frac{2939}{628}$.)

Celt, triangular, of mottled dark green jadeite. Length 6.2 cm., breadth 3.4 cm. Pl. XXXIV, Fig. 7. (Cat. No. $\frac{2939}{349}$.)

Celt of pale green, translucent jadeite. Length 7.5 cm., breadth 1.9 cm. Pl. XXXIV, Fig. 8. (Cat. No. $\frac{2939}{276}$.)

Celt of pale green, translucent jadeite. Length 9.1 cm., breadth 1.4 cm. Pl. XXXIV, Fig. 9. (Cat. No. $\frac{2939}{1625}$.)

B. Worn in Horizontal Position.

(*a*) *Designs of Alligators or Fishes.*

A small number of the celt-shaped oblong, rectangular amulets have been provided with two or more circular holes along the upper side for suspension in a horizontal position. Most of these objects are thin and flat on both sides, but some show the upper side convex. Most of the objects represent alligators with a head with upturned snout seen in profile at each end, the body being in common. Only

two specimens, Pl. XXXVIII, Figs. 8 and 10, have come under my observation, representing a fish as plainly shown both by the shape of the head and body and by the fins.

The following specimens illustrate the forms above described.

Anterior half of alligator of serpentine. Length 13.1 cm., breadth 2.3 cm. Pl. XXXVIII, Fig. 1. (Cat. No. $\frac{2939}{1157}$.)

Alligator of quartz. Length 11.5 cm., breadth 2.5 cm. Pl. XXXVIII, Fig. 2. (Cat. No. $\frac{2939}{1155}$.)

Alligator head, body missing, of mottled, whitish yellow stone. Length 6.9 cm., breadth 2.4 cm. Pl. XXXVIII, Fig. 3. (Cat. No. $\frac{2939}{1152}$.)

Alligator of pale green bowenite (?). Length 14.2 cm., breadth 2.4 cm. Pl. XXXVIII, Fig. 4. (Cat. No. $\frac{2939}{1154}$.)

Alligator of pale green bowenite. Front side slightly convex, back flat. Length 19.5 cm., breadth 3 cm. Pl. XXXVIII, Fig. 5. (Cat. No. $\frac{2438}{828}$.)

Head of alligator of green stone, highly conventionalized. Length 7.5 cm., breadth 2.2 cm. Pl. XXXVIII, Fig. 6. (Cat. No. $\frac{2939}{1162}$.)

Alligator of gray stone. Length 14.7, breadth 2 cm. Pl. XXXVIII, Fig. 7. (Nat. Mus. of Costa Rica, No. 7858.)

Fish of stone. Length 10.2 cm., breadth 4.1 cm. Pl. XXXVIII, Fig. 8. (Nat. Mus. of Costa Rica, No. 7712.)

Anterior half of alligator, serpentine. Length 8.8 cm., breadth 1.9 cm. Pl. XXXVIII, Fig. 9. (Cat. No. $\frac{2939}{1160}$.)

Fish of pale green bowenite, tail missing. Length 11.5 cm., breadth 4 cm. Pl. XXXVIII, Fig. 10. (Cat. No. $\frac{2939}{1161}$.)

Alligator (?) of gypsum, highly conventionalized. Length 11.9 cm, breadth 2.5 cm. Pl. XXXVIII, Fig. 11. (Cat. No. $\frac{2939}{1156}$.)

Alligator head of mottled, whitish yellow stone. Length 12.7 cm., breadth 2.2 cm. Pl. XXXVIII, Fig. 13. (Cat. No. $\frac{2939}{1153}$.)

Anterior half of alligator, serpentine. Length 19.6 cm., breadth 2.9 cm. Pl. XXXVIII, Fig. 16. (Cat. No. $\frac{2939}{1158}$.)

(b) Plain or with Simple Band Designs.

A few specimens of this rather sparingly represented group are illustrated on Pl. XXXVIII. Of this group, Figs. 14, 17, 18 show plain specimens, and Figs. 12, 15 and Pl. XXXVII, Fig. 27, some with vertical incised bands.

Plain amulet of greenish bowenite, adorned with two transverse, elevated, incised bands. Length 10.3 cm., breadth 3.7 cm. Pl. XXXVIII, Fig. 12. (Cat. No. $\frac{2939}{1163}$.)

Plain amulet of bluish jade. Length 11. 9 cm., breadth 2.2 cm. Pl. XXXVIII. Fig. 14. (Cat. No. $\frac{2939}{1159}$.)

Plain amulet of dark green bowenite, with an incised band at each end. Length 10 cm., breadth 2.9 cm. Pl. XXXVIII, Fig. 15. (Cat. No. $\frac{2438}{831}$.)

Plain amulet of bluish green jade (?). Length 8.4 cm., breadth 3.4 cm. Pl. XXXVIII, Fig. 17. (Cat. No. $\frac{2939}{1168}$.)

Plain amulet of mottled blackish green stone. Length 6.5 cm., breadth 3 cm. Pl. XXXVIII, Fig. 18. (Cat. No. $\frac{2939}{1169}$.)

Amulet of serpentine worn in horizontal position, adorned with an incised transverse band at each end. Length 4.9 cm., breadth 3.9 cm. Pl. XXXVII, Fig. 27, (Cat. No. $\frac{2939}{1164}$.)

2. Figurines Sculptured in the Round.

(*a*) *Human Figurines and Heads.*

Of the human figurines or statuettes found at Las Guacas, which represent entire human figures, there are hardly any which do not more or less plainly betray their derivation from the celt-shaped amulets. They have therefore been classified in the above with that class of objects and are illustrated on Pl. XXXV, Figs. 7, 8. Of human heads in stone there are, however, a small number of diminutive forms encountered here, all provided with holes for suspension, which, not being celt-shaped, have to be grouped apart. Some of these perhaps owe their existence to the celt manufacture, having been made out of chips of the precious stone celts. A number of these human heads are illustrated on the plates.

Human head of pale green bowenite with a transverse boring at the neck for suspension. Height 2.6 cm., breadth 2 cm. Pl. XXXIX, Fig. 1. (Nat. Mus. of Costa Rica, No. 8406.)

Human head of dark green jade with an angular tattoo-mark extending over each cheek to the nose. Height 2.8 cm., breadth 2.3 cm. Pl. XXXIX, Fig. 2. (Nat. Mus. of Costa Rica, No. 8406.)

Human head of pale green stone with flat skull. Height 2.3 cm., breadth 1.3 cm. Pl. XXXIX, Fig. 3. (Cat. No. $\frac{2438}{874}$.)

Human head of white stone, features partly obliterated. Height 2.2. cm., breadth 1.4 cm. Pl. XXXIX, Fig. 4. (Cat. No. $\frac{2438}{876}$.)

Human head of white gypsum with prolonged chin and head-dress. Height 6.6 cm., breadth 2.8 cm. Pl. XXXIX, Fig. 5. (Cat. No. $\frac{2939}{1262}$.)

Human head crudely executed, of greenish stone. Height 2.1 cm., breadth 1.5 cm. Pl. XXXIX, Fig. 6. (Cat. No. $\frac{2939}{1265}$.)

Human head of pale green bowenite with an incision around its front. Height 2.7 cm., breadth 1.8 cm. Pl. XXXIX, Fig. 7. (Cat. No. $\frac{2939}{1266}$.)

Human head of gray stone with a peculiar head-dress. Height 3.3 cm., breadth 2.5 cm. Pl. XXXIX, Fig. 8. (Cat. No. $\frac{2939}{1276}$.)

Oblong, flat bead-shaped amulet of pale green stone with a human face carved on either side. Fig. 12 shows a face with open and Fig. 13 a face with closed eyes. Length 3.5 cm., breadth 2.4 cm. Pl. XXXIX, Figs. 12, 13. (Cat. No. $\frac{2939}{1270}$.)

Human head of quartz, features partly obliterated. Height 2.9 cm., breadth 2.1 cm. Pl. XXXIX, Fig. 15. (Cat. No. $\frac{2438}{876}$.)

Human head of pale green stone with very elaborate head-dress, ear and breast ornaments. Height 5.5 cm., breadth 4.3 cm. Pl. XXXIX, Fig. 19. (Nat. Mus. of Costa Rica.)

(*b*) *Animal Figurines and Heads.*

Of the mammalia only two groups seem to be represented in any numbers. The one contains the animal, always represented with a large, erect tail and described and figured on page 26 from my own excavations at Las Guacas. The other group consists of bats. Pl. XL, Figs. 1–17 and Pl. XLI, Figs. 1–9, show some representations of the unidentified animal (the ant-bear?) with the erect tail. Pl. XLIV, Figs. 6, 7, illustrates variants of the bat. Other mammal types are very rare.

Unknown animal (ant-bear?) with broad tail, of gray bowenite. Height 1.9 cm., length 5.1 cm. Pl. XL, Fig. 1. (Cat. No. $\frac{2939}{12320}$.)

Animal of green bowenite, with tail turned upwards. Height 2.6 cm., length 4 cm. Pl. XL, Fig. 2. (Cat. No. $\frac{2939}{1209}$.)

Animal of stone. Height 3.8 cm., length 5.2 cm. Pl. XL, Fig. 3. (Nat. Mus. of Costa Rica, No. 3388.)

Animal of stone. Height 3.5 cm., length 4.2 cm. Pl. XL, Fig. 4. (Nat. Mus. of Costa Rica, No. 10868.)

Animal of green bowenite. Height 2.1 cm., length 3.8 cm. Pl. XL, Fig. 5 (Cat. No. $\frac{2939}{1212}$.)

Animal of green bowenite. Height 1.8 cm., length 4.3 cm. Pl. XL, Fig. 6. (Cat. No. $\frac{2939}{1210}$.)

Animal of stone. Height 3 cm., length 5.4 cm. Pl. XL, Fig. 7. (Nat. Mus. of Costa Rica, No. 8404.)

Animal of gray jade (?). Height 2.9 cm., length 5.2 cm. Pl. XL, Fig. 8. (Cat. No. $\frac{2438}{844}$.)

Animal of green bowenite with broad tail. Height 1.5 cm., length 3.9 cm. Pl. XL, Fig. 9. (Cat. No. $\frac{2939}{1213}$.)

Animal of stone. Height 2.5 cm., length 4.1 cm. Pl. XL, Fig. 10. (Nat. Mus. of Costa Rica, No. 10889.)

Animal of green jade. Height 3.5 cm., length 5.3 cm. Pl. XL, Fig. 11. (Cat. No. $\frac{2939}{1293}$.)

Animal of stone. Height 1.8 cm., length 4.2 cm. Pl. XL, Fig. 12. (Nat. Mus. of Costa Rica, No. 10781.)

Animal of stone. Height 2 cm., length 3 cm. Pl. XL, Fig. 13. (Cat. No. $\frac{2939}{1221}$.)

Animal of bluish jade. Height 2.1 cm., length 3.7 cm. Pl. XL, Fig. 14. (Cat. No. $\frac{2939}{1206}$.)

Animal of bluish jade. Height 1.5 cm., length 3 cm. Pl. XL, Fig. 15. (Cat. No. $\frac{2939}{1214}$.)

Animal of bluish jade. Height 1.1 cm., length 2.4 cm. Pl. XL, Fig. 16. (Cat. No. $\frac{2793}{41}$.)

Bat, with wings spread, of dark green bowenite. Height 4.8 cm., breadth 9.2 cm. Pl. XLI, Fig. 1. (Cat. No. $\frac{2939}{1183}$.)

Bat of gray stone. Height 3.2 cm., breadth 3.6 cm. Pl. XLI, Fig. 2. (Cat. No. $\frac{2438}{837}$.)

Bat of green bowenite, body ornamented with circular impressions. Height 4.3 cm., breadth 5.2 cm. Pl. XLI, Fig. 3. (Cat. No. $\frac{2438}{836}$.)

Bat of green jade. Height 4.2 cm., breadth 6.7 cm. Pl. XLI, Fig. 4. (Cat. No. $\frac{2939}{1184}$.)

Bat, conventionalized, of stone. Height 4.4 cm., breadth 7.6 cm. Pl. XLI, Fig. 5. (Nat. Mus. of Costa Rica, No. 8130.)

Bat or owl of stone. Height 4.2 cm., breadth 11 cm. Pl. XLI, Fig. 6. (Nat. Mus. of Costa Rica, No. 8490.)

Bat of stone. Height 3.8 cm., breadth 5.3 cm. Pl. XLI, Fig. 7. (Nat. Mus. of Costa Rica, No. 8133.)

Bat of green jade. Height 3.9 cm., breadth 4.9 cm. Pl. XLI, Fig. 8. (Cat. No. $\frac{2939}{1185}$.)

Bat or owl of stone. Height 6 cm., breadth 8 cm. Pl. XLI, Fig. 9. (Nat. Mus. of Costa Rica, No. 8342 (?).)

Amulet plain of green bowenite, possibly derived from the bat or owl. Height 3.3 cm., breadth 4.1 cm. Pl. XLI, Fig 15. (Cat. No. $\frac{2939}{1292}$.)

Head of a wolf (?), of pale green bowenite. Height 2.5 cm., breadth 1.3 cm. Pl. XXXIX, Fig. 9. (Cat. No. $\frac{2939}{1275}$.)

Head of wolf (?), pale green bowenite (?). Height 2.6 cm., breadth 1.9 cm. Pl. XXXIX, Fig. 10. (Cat. No. $\frac{2438}{872}$.)

Head of wolf (?), pale green bowenite. Height 2.3 cm., breadth 2.3 cm. Pl. XXXIX, Fig. 11. (Cat. No. $\frac{2939}{1274}$.)

Head of deer of green bowenite. Height 2.8 cm., breadth 2.7 cm. Pl. XXXIX, Fig. 14. (Cat. No. $\frac{2939}{1272}$.)

Head of deer of pale green bowenite. Length 3.2 cm., breadth 1.7 cm. Pl. XXXIX, Fig. 22. (Cat. No. $\frac{2939}{1273}$.)

Animal of grayish green stone. Height 2.5 cm., breadth 1.4 cm. Pl. XLI, Fig. 10. (Cat. No. $\frac{2939}{1200}$.)

(*c*) *Bird Figurines and Heads.*

Of the bird figurines only one group occurs in any numbers. This bird is characterized by a very long slender beak, and is apparently a water bird. The bird is represented by a head, neck and simply an appendix for the body. The same type has also been figured in the above from my own excavations. Most of these birds are made of green stone. A bird's head of another type is shown on Pl. XXXIX, Fig. 17. See the following plates.

Bird head of bowenite with long, slender beak, body highly reduced, appendix-like. Height 3.7 cm. Pl. XL, Fig. 17. (Cat. No. $\frac{2939}{1231}$.)

Bird or bird's head of bowenite. Height 4.2 cm. Pl. XL, Fig. 18. (Cat. No. $\frac{2939}{1229}$.)

Bird of bowenite. Height 3.7 cm. Pl. XL, Fig. 19. (Cat. No. $\frac{2939}{1230}$.)

Bird of dark green bowenite. Height 2.7 cm. Pl. XL, Fig. 20. (Cat. No. $\frac{2939}{1240}$.)

Bird of bowenite. Height 3.3 cm. Pl. XL, Fig. 21. (Cat. No. $\frac{2939}{1234}$.)

Bird of bowenite. Height 2.8 cm. Pl. XL, Fig. 22. (Cat. No. $\frac{2939}{1246}$.)

Bird of bowenite. Height 3.5 cm. Pl. XL, Fig.X 23. (Cat. No. $\frac{2438}{858}$.)

Bird head of gray stone. Length 2.7 cm., breadth 1.7 cm. Pl. XXXIX, Fig. 17. (Cat. No. $\frac{2939}{1277}$.)

(*d*) *Various Animals of the Lower Orders.*

There are a number of artistically executed figures of frogs with the four legs spread. These too are nearly all of green stone. Compare Pl. XLI, Figs. 11, 13, 14, 17, 19, 20, 23 which show both realistic and conventionalized forms. There are even a few representations of turtles (see Pl. XLI, Figs. 16, 18) and of an alligator or lizard (see Pl. XLI, Figs. 21, 22).

Frog of gray stone. Length 4.9 cm., breadth 3.2 cm. Pl. XLI, Fig. 11. (Cat. No. $\frac{2939}{1187}$.)

Frog (?), conventionalized. Length 7.2 cm., breadth 5.4 cm. Pl. XLI, Fig. 12. (Nat. Mus. of Costa Rica, No. 8132.)

Frog of pale green bowenite. Length 4.6 cm., breadth 4 cm. Pl. XLI, Fig. 13. (Cat. No. $\frac{2939}{1189}$.)

Frog of stone. Length 4.6 cm., breadth 4.3 cm. Pl. XLI, Fig. 14. (Nat. Mus. of Costa Rica, No. 3356.)

Turtle of gray stone. Length 3.3 cm., breadth 2.9 cm. Pl. XLI, Fig. 16. (Cat. No. $\frac{2438}{843}$.)

Frog of serpentine. Length 3 cm., breadth 1.9 cm. Pl. XLI, Fig. 17. (Cat. No. $\frac{2438}{842}$.)

Turtle of serpentine. Length 5.5 cm., breadth 3.5 cm. Pl. XLI, Fig. 18. (Cat. No. $\frac{2939}{1186}$.)

Frog of quartz. Length 4.4 cm., breadth 3.5 cm. Pl. XLI, Fig. 19. (Cat. No. $\frac{2939}{1186}$.)

Frog of quartz, conventionalized. Length 3.2 cm., breadth 2.8 cm. Pl. XLI, Fig. 20. (Cat. No. $\frac{2939}{1188}$.)

Alligator (?) of pale green bowenite. Length 5.4 cm., breadth 1.1 cm. Pl. XLI, Fig. 21. (Cat. No. $\frac{2939}{1145}$.)

Lizard (?) of bowenite. Length 8.8 cm., breadth 2.4 cm. Pl. XLI, Fig. 22. (Cat. No. $\frac{2939}{1194}$.)

Frog of pale green bowenite. Length 4.2 cm., breadth 2.4 cm. Pl. XLI, Fig. 23. (Cat. No. $\frac{2438}{841}$.)

3. Tubes.

Long cylindrical tubes resembling those here figured from Las Guacas were, as is well known, worn by the ancient Mayas and Mexicans as horizontal breast-ornaments. Beside their use as amulets they probably also served other purposes. The use of cane tubes by the medicine men for sucking prevails still in certain parts of Mexico as amongst the Tarahumares in Chihuahua. About the use of stone tubes for this purpose amongst the aborigines of California it may be of interest to give the following quotation[20] from E. G. Squier after Vanegas, "One mode (for curing disease) was very remarkable, and the good effect it sometimes produced heightened the reputation of the physician. They applied to the suffering part of the patient's body the *chacuaco*, a tube formed out of a very hard black stone; and through this they sometimes sucked and at other times blew, but both as hard as they were able, supposing that the disease was either exhaled or dispersed. Sometimes the tube was filled with cimarron or wild tobacco lighted and here they either sucked in or blew down the smoke, according to the physician's directions; and this powerful caustic sometimes without any other remedy has been known to entirely remove the disorder."

Quite a number of stone tubes varying in size and shape were encountered at Las Guacas. The largest are 12–20 cm. in length. They are all provided with a

[20] Squier, E. G. and E. H. Davies. Ancient Monuments, etc. Smiths. Contrib., Vol. I, p. 227. Vanegas, California, Vol. I, p. 97.

cylindrical perforation passing through from one end to the other. Most of the tubes are almost perfectly cylindrical, as shown on Pl. XLII, Figs. 23, 24; others are cylindrical but tapering towards the ends, as shown on Pl. XLII, Fig. 27; while a few show somewhat flattened sides, as shown on Pl. XLII, Fig. 22, and still others are perfectly square in section as on Pl. XLII, Fig. 26. A few are encircled with raised bands and contracted at their ends, as illustrated on Pl. XLII, Fig. 21. Most of the tubes are of stones of beautiful color and highly polished.

Cylindrical tube of serpentine with a band incision at each end. Length 25.5 cm., thickness 2 cm. Pl. XLII, Fig. 23. (Cat. No. $\frac{2939}{1401}$.)

Cylindrical tube of serpentine, ornamented with encircling incisions near each end. Length 28.4 cm., diameter 2.5 cm. Pl. XLII, Fig. 24. (Cat. No. $\frac{2939}{1398}$.)

Cylindrical tube of bowenite, somewhat curved and ornamented with encircling incisions near each end. Length 5.3 cm., diameter 1.5 cm. Pl. XLII, Fig. 25 (Cat. No. $\frac{2939}{1400}$.)

Quadrangular tube of mottled greenish stone. Length 17.7 cm., thickness 1.6. cm. Pl. XLII, Fig. 26. (Cat. No. $\frac{2939}{1420}$.)

Cylindrical tube of serpentine with an elevated band ornament encircling each end. Length 18.7 cm., diameter 1.8 cm. Pl. XLII, Fig. 27. (Cat. No. $\frac{2939}{1402}$.)

4. Beads.

These served for necklaces. They are all sizes and shapes: flat-cylindrical, round, tubular and olive-shaped. The flat-cylindrical are usually the smallest, and the only ones which seem to have been manufactured in any number large enough to have served for necklaces. Most of the other beads, to judge from my own finds, and the information obtained from the most experienced grave-plunderers of Nicoya, occur very sparingly, only one or two or a very few being met with to a skeleton. They, on account of their high value and scarcity, were perhaps used as pendants on necklaces, which may have consisted of shells, seeds, wood or other perishable material. All the characteristic forms of beads of Las Guacas have been figured in the previous text in the description of my own excavations on the spot. The very large, clumsy beads of olive-shape are peculiar, some apparently being pebbles which still retain their irregular form.

Small oblong, ring-shaped bead of bowenite (?). Length 1.6 cm., breadth 1.2 cm. Pl. XLII, Fig. 15. (Cat. No. $\frac{2438}{935}$.)

Globular bead of quartz. Diameter 1.6 cm. Pl. XLII, Fig. 16. (Cat. No. $\frac{2939}{1606}$.)

Flat-cylindrical bead of bowenite. Diameter 1.5 cm. (The writer's excavations at Las Guacas.) Pl. XLII, Fig. 28. (Cat. No. $\frac{2793}{100}$.)

Flat-cylindrical bead of bowenite. Diameter 1.1 cm. Pl. XLII, Fig. 29. (Cat. No. $\frac{2939}{10068}$.)

5. *Various Small Objects without any Biomorphic Features.*

Under this group there are brought together a number of small artefacts, delicately executed and shaped as buttons, rings, cylinders, cups, bells, plates, etc. They are all pierced with holes for suspension and apparently have served as amulets, some probably as ear or lip ornaments, others as pendants for necklaces, etc. The following specimens illustrate the forms mentioned above.

Ring-shaped object of serpentine, of unknown use, but possibly for lip or ear ornament.[21] Diameter 3.4 cm., thickness 1.8 cm. Pl. XLII, Fig. 1. (Cat. No. $\frac{2438}{929}$.)

Same ring-shaped object seen from above, showing the almost funnel-shaped interior. Pl. XLII, Fig. 2.

Disk-shaped button of quartz. Diameter 3.3 cm., thickness 1.1 cm. Pl. XLII, Fig. 3. (Cat. No. $\frac{2438}{933}$.)

Same disk-shaped button of quartz from the back, showing perforated shank. Pl. XLII, Fig. 4.

Round button of greenish bowenite with circular depression in the center. Diameter 3.3 cm., thickness .8 cm. Pl. XLII, Fig. 5. (Cat. No. $\frac{2438}{932}$.)

Same button seen from below. Pl. XLII, Fig. 6.

Round button of serpentine with circular depression in the center. Diameter 3.1 cm., thickness 1.5 cm. Pl. XLII, Fig. 7. (Cat. No. $\frac{2939}{1308}$.)

Same button seen from below. Pl. XLII, Fig. 8.

Round button of quartz, with circular depression in the center. Diameter 3.5 cm., thickness 1.4 cm. Pl. XLII, Fig. 9. (Cat. No. $\frac{2438}{931}$.)

Same button seen from below. Pl. XLII, Fig. 10.

Button of quartz, oblong, disk-shaped. Length 2.7 cm., breadth 2.4 cm. Pl. XLII, Fig. 11. (Cat. No. $\frac{2939}{1302}$.)

Same button seen from below. Pl. XLII, Fig. 12.

Ring-shaped object of quartz, resembling Fig. 1, Pl. XLII. Diameter 3.5 cm., thickness 1.8 cm. Pl. XLII, Fig. 13. (Cat. No. $\frac{2438}{930}$.)

Plate of mottled green jade, small, rectangular, at the ends dilated and provided with pairs of holes for fastening. Use unknown. Length 3.8 cm., breadth 1.4 cm. Pl. XLII, Fig. 14. (Cat. No. $\frac{2939}{1178}$.)

Bell of gray stone. Height 2.4 cm., breadth 2 cm. Pl. XXXIX, Fig. 16. (Cat. No. $\frac{2939}{1351}$.)

[21] Compare "Veröffentlichungen aus dem Königlichen Museum für Völkerkunde." I Band, I Heft. Berlin, 1889, p. 6, Pl. IV.

Pair of ear tubes (?) of gray stone, cylindrical, hollow. Height. 3.2 cm., breadth 1.8 cm. Pl. XXXIX, Figs. 18, 20. (Cat. No. $\frac{2939}{1319\text{-}1320}$.)

Bell of gray quartz. Height 3 cm., breadth 2.5 cm. Pl. XXXIX, Fig. 21. (Cat. No. $\frac{2939}{1330}$.)

Circular disk of pale green bowenite, two suspension holes near periphery at opposite ends. Upper side slightly convex, under side flat. Diameter 3.9 cm. Pl. XLII, Fig. 17. (Cat. No. $\frac{2939}{1299}$.)

Circular disk of serpentine with two holes close together near the upper end. Both sides flat. Diameter 3.7 cm. Pl. XLII, Fig. 18. (Cat. No. $\frac{2438}{937}$.)

Rectangular button of quartz, with circular depression in the center. Length 2.3 cm., breadth 1.8 cm. Pl. XLII, Fig. 19. (Cat No. $\frac{2939}{1303}$.)

Same rectangular button of quartz seen from below. Pl. XLII, Fig. 20.

Square tube of green jade, corners rounded, ornamented with elevated encircling ridges or bands at the ends and center. Length 8.6 cm., breadth 12. cm. Pl. XLII, Fig. 21. (Cat. No. $\frac{2939}{1404}$.)

Nearly quadrangular tube or bead of greenish, mottled stone. Length 4.5 cm., thickness 1.5 cm. Pl. XLII, Fig. 22. (Cat. No. $\frac{2939}{1421}$.)

Bell of gray stone. Height 2 cm., breadth 1.8 cm. Pl. XXXIX, Fig. 23. (Cat. No. $\frac{2939}{1351}$.)

Bell of gray stone. Height 3 cm., breadth 2.5 cm. Pl. XXXIX, Fig. 24. (Cat. No. $\frac{2793}{129}$.)

Diminutive, globular cup of bowenite. Height 3.5 cm., breadth 4.8 cm. Pl. XXXIX, Fig. 25. (Cat. No. $\frac{2939}{1314}$.)

Cylinder, compact of gray stone, encircled by an incision near the base and one near the top. Height 2.2 cm., breadth 1.6 cm. Pl. XXXIX, Fig. 26. (Cat. No. $\frac{2939}{1328}$.)

Oblong, flat amulet of obsidian with a perforated knob at the top. Height 6.3 cm., breadth 7.6 cm. Pl. XXXIX, Fig. 27. (Cat. No. $\frac{2939}{1291}$.)

Compact cylinder of pale green bowenite, widening towards the base and encircled by an incision near each end. Height 2.4 cm., breadth 1.6 cm. Pl. XXXIX, Fig. 28. (Cat. No. $\frac{2939}{1325}$.)

Diminutive cup of green bowenite. Height 2.6 cm., breadth 2.3 cm. Pl. XXXIX, Fig. 29. (Cat. No. $\frac{2939}{1318}$.)

Almost spool-shaped object (lip-plug?), of serpentine. Height 1.8 cm., diameter 2.3 cm. Pl. XXXIX, Fig. 30. (Cat. No. $\frac{2939}{1307}$.)

Buckle-shaped object of quartz. Use unknown. Length 4.3 cm., breadth 1.6 cm. Pl. XXXIX, Fig. 31. (Cat. No. $\frac{2939}{1298}$.)

Buckle-shaped object of dark green stone. Length 4 cm., breadth 2.9 cm. Pl. XXXIX, Fig. 32. (Nat. Mus. of Costa Rica, Velasco Coll.)

Buckle-shaped object of quartz. Length 4.7 cm., breadth 2.7 cm. Pl. XXXIX. Fig. 33. (Cat. No. $\frac{2939}{12977}$.)

Cylinder, compact of dark green bowenite, adorned with encircling incisions at both ends. Height 3.4 cm., diameter 1.8 cm. Pl. XXXIX, Fig. 34. (Cat. No. $\frac{2939}{13211}$.)

Objects of Jade and Other Green Stones of Las Guacas.

The burial-ground of Las Guacas has produced far more objects of jade than all other ancient sites of Southern Central America combined. Hundreds of specimens of jade, comprising all forms of amulets, beads, tubes, etc., have been found in this small spot. The term "jade" is then, as by previously quoted archeologists, p. 13, used in its common and widest, not in its strict mineralogical sense, comprising only jadeite and nephrite. Most of these "jades" are objects of bowenite, pale to dark green, or saussurite, bluish green, often with white spots, while the more or less translucent jadeites are less numerous. No close mineralogical investigation has however been made as yet of the jade objects of the Costa Rican collections of the Carnegie Museum, but I am indebted to Professor L. P. Gratacap of the American Museum of Natural History in New York for the general determination of the most conspicuous of the minerals represented in these collections. Professor Amos P. Brown[22] of the University of Pennsylvania, who has published a study based on the Velasco collection, which was deposited in Philadelphia, considers it to contain "probably the best assemblage of worked (American) jade in existence."

In my previous excavations during 1897 in other burial-grounds of Nicoya and its surroundings, I found jade ornaments in the graves but sparingly. Few of those from other localities were so large and elaborate as those of Las Guacas. On the whole mainland of Costa Rica objects of jade are very rare. In all my excavations on the highlands I only came across a few small beads of this mineral. But some fine specimens of jade amulets have been found sporadically in graves on the slopes of Irazu, and even on the Atlantic coast at Mercedes, and one or two other places. All these finds, however, have been of Nicoyan origin. On the Pacific side of Nicaragua jade objects also have been reported, but even all of these which I have seen show forms identical to those characteristic of Nicoya. The extensive excavations at Chiriqui seem only to have brought to light a single specimen of jade, a common type of the Nicoyan plain amulets included in the collections of the Yale University Museum.

[22] Brown, Amos P. "Jade and similar green stones." Bull. Free Museum of Science and Art of the University of Pennsylvania, April, 1898, p. 145.

In Salvador no single object of jade has to my knowledge been found. In Guatemala and Honduras jade objects again appear, but as yet not very numerous finds have been made. Whether the jade for these objects was found in these states or whether it was obtained from the rich veins of southern Mexico has yet to be found out by research.

No indication of the source of the ancient supply of the jades of Nicoya has as yet been discovered. Very likely, however, a mine may be located some day in the neighborhood of Las Guacas, as not only the great majority of all jade artefacts have been found here, but also worked blocks of the crude stone, proving that celt-

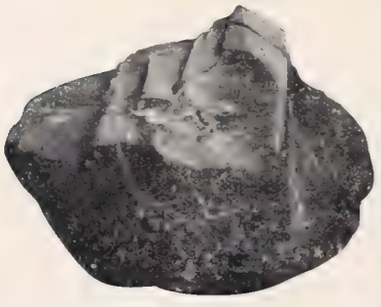


FIG. 71. Block of jadeite (⅓). (Nat. Mus. of Costa Rica, No. 9096.)

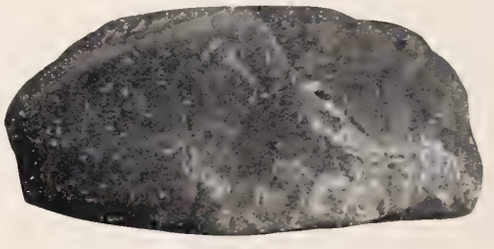


FIG. 72. Same Block of jadeite seen from the back (⅓).

shaped amulets were probably manufactured at this very spot. The largest specimen of a similar core of pure, translucent jadeite encountered is the one represented by Text Figs., 71, 72, which belongs to the Velasco collection of the National Museum of Costa Rica. Another, a large water-worn pebble of pure translucent jadeite from Las Guacas is illustrated by Pl. XXXII, Figs. 3 and 4, and a worked block of bowenite by Pl. XXXII, Figs. 1 and 2.

Ornamental objects of jade were almost exclusively manufactured in Nicoya. This precious mineral was hardly ever used for tools. Only a couple of small celts of jade, which have served as tools, are found in the Velasco collections of the Carnegie Museum.

A mineralogical study of jade objects of the United States National Museum of Washington has been published by F. W. Clarke and G. P. Merrill,[23] and this paper includes six specimens from Las Guacas and a few from other places of Nicoya.

In the monumental and elaborate work of Heber R. Bishop: "Investigations and Studies in Jade," color reproductions are given of a few objects of jade, mostly celts, from Guatemala and New Mexico.

In the present work, on Pls. XLIII, XLIV, XLV, are brought together and

[23] F. W. Clarke and G. P. Merrill. "On Nephrite and Jadeite." *Proc. of the U. S. Nat. Mus.*, 1888, pp. 115–130.

reproduced in colors a number of representative objects of jade and other green stones from Las Guacas in order to show the different tints, and texture variants, characteristic of the jades of this locality.[24] For comparison, on Pl. XLVI, is reproduced a collection of jade objects, characteristic types, from the state of Oaxaca, where ornaments of jade are more numerous than elsewhere in Mexico. The objects belong to Mr. George G. Heye of New York City and were obtained from Dr. Carl Lumholtz and other collectors.

The jade objects reproduced in color, of the Velasco collection are the following:

Amulet, human figure of translucent, bluish green jadeite, highly polished. Tattoo marks on the arms above the elbows. Length 8.4 cm., breadth 3.7 cm. Pl. XLIII, Fig. 1. (Cat. No. $\frac{2939}{406}$.)

Amulet, human figure with high head-dress and arms crossed on breast. Material, yellowish green, highly polished stone. Length 14.3 cm., breadth 4.3 cm. Pl. XLIII, Fig. 2. (Cat. No. $\frac{2939}{266}$.)

Amulet of bluish green, highly polished jadeite, oblong, flat and thin, representing a conventionalized human figure ornamented with a head-dress. Length 18.7 cm., breadth 5.4 cm. Pl. XLIII, Fig. 3. (Cat. No. $\frac{2939}{262}$.)

Amulet of bluish green, highly polished, translucent jadeite; divided lengthwise, and representing a human figure with high head-dress. Length 17 cm., breadth 2.2 cm. Pl. XLIII, Fig. 4. (Cat. No. $\frac{2939}{410}$.)

Amulet, divided lengthwise, of bluish green, translucent, highly polished jadeite, representing a conventionalized human figure. Length 17.8 cm., breadth 1.3 cm. Pl. XLIII, Fig. 5. (Cat. No. $\frac{2939}{412}$.)

Bird-shaped amulet of bluish green, highly polished jadeite. Length 7 cm., breadth 1.8 cm. Pl. XLIII, Fig. 6. (Cat. No. $\frac{2939}{549}$.)

Amulet of bluish green, white mottled, highly polished jadeite, triangular, plain, thin, flat and translucent. Length 6.2 cm., breadth 3.4 cm. Pl. XLIII, Fig. 7. (Cat. No. $\frac{2939}{971}$.)

Celt-shaped amulet of bluish green, highly polished, translucent jadeite. Length 7.5 cm., breadth 1.8 cm. Pl. XLIII, Fig. 8. (Cat. No. $\frac{2939}{924}$.)

Celt-shaped amulet, slender and translucent, of bluish green, highly polished jadeite. Length 9 cm., breadth 1.3 cm. Pl. XLIII, Fig. 9. (Cat. No. $\frac{2939}{923}$.)

Bird-shaped amulet, flat and thin, of translucent, bluish green, highly polished jadeite. Length 5.8 cm., breadth 4.7 cm. Pl. XLIII, Fig. 10. (Cat. No. $\frac{2939}{539}$.)

Bird-shaped amulet of bluish green, translucent, highly polished jadeite. Pl. XLIV, Fig. 1. (Cat. No. $\frac{2939}{529}$.)

[24] On Plates XLV and XLVI the green color is too pronounced.

Bird-shaped amulet of translucent, highly polished grayish blue jadeite with whitish streaks. Length 6.3 cm., breadth 2.7 cm. Pl. XLIV, Fig. 2. (Cat. No. $\frac{2939}{580}$.)

Amulet of bluish green, highly polished jadeite, representing human figure with hands meeting on breast. Length 6.7 cm., breadth 3 cm. Pl. XLIV, Fig. 3. (Cat. No. $\frac{2939}{301}$.)

Bird-shaped amulet of dark bluish green, highly polished jadeite. Length 6.1 cm., breadth 2.9 cm. Pl. XLIV, Fig. 4. (Cat. No. $\frac{2939}{530}$.)

Bird-shaped amulet of pale bluish green, highly polished stone. Length 6.8 cm., breadth 2.1 cm. Pl. XLIV, Fig. 5. (Cat. No. $\frac{2939}{579}$.)

Amulet of highly polished, dark bluish green jadeite in the shape of a bat with spread wings, which are covered with incised designs. The symmetrical designs on both wings each represent a human face enframed by a V-shaped band with guilloche patterns. At the upper end of each wing there is the head of an animal with upturned nose, and below this there are groups of parallel incised lines by which the artist apparently designated the fingers. (Compare the bats on Pl. XLI.) This object represents undoubtedly the most perfect specimen of workmanship in precious stone ever found in Costa Rica. Its weight is 11 ounces, length 15.3 cm., height 4.1 cm. Pl. XLIV, Fig. 6. (Cat. No. $\frac{2939}{1181}$.)

Bat-shaped amulet with spread wings, of pale bluish gray, highly polished stone. Length 8.8 cm., height 2.8 cm. Pl. XLIV, Fig. 7. (Cat. No. $\frac{2939}{1182}$.)

Bird-shaped amulet of bowenite, highly polished. Length 9.3 cm., breadth 3.6 cm. Plate XLIV, Fig. 8. (Cat. No. $\frac{2939}{520}$.)

Bird-shaped amulet of partly whitish, partly pale greenish blue, highly polished jadeite. Length 7.4 cm., breadth 3.8. cm. Pl. XLIV, Fig. 9. (Cat. No. $\frac{2939}{523}$.)

Bird-shaped amulet of dark green bowenite of dull luster. Length 8.3 cm., breadth 1.6 cm. Pl. XLIV, Fig. 10. (Cat. No. $\frac{2939}{548}$.)

Bird-shaped amulet of mottled dark green, highly polished jadeite (?). Length 10.5 cm., breadth 4.4 cm. Pl. XLIV, Fig. 11. (Cat. No. $\frac{2939}{519}$.)

Amulet of bluish green jadeite, representing an animal. Length 2.9 cm., breadth 1.7 cm. Pl. XLV, Fig. 1. (Cat. No. $\frac{2939}{1251}$.)

Diminutive ax-like amulet of greenish blue jade. Length 2.5 cm., breadth 1.1 cm. Pl. XLV, Fig. 2. (Cat. No. $\frac{2939}{1003}$.)

Thin celt-shaped amulet of translucent, bluish green jadeite, with hole for suspension near the lower end. Length 7.1 cm., breadth 3 cm. Pl. XLV, Fig. 3. (Cat. No. $\frac{2939}{925}$.)

Amulet of greenish blue saussurite, representing an animal with upturned tail. Length 2.9 cm., height 2.2 cm. Pl. XLV, Fig. 4. (Cat. No. $\frac{2939}{1216}$.)

Amulet of greenish blue saussurite, representing an animal with upturned tail. Length 4.7 cm., height 2.8 cm. Pl. XLV, Fig. 5. (Cat. No. $\frac{2939}{12603}$.)

Celt-shaped amulet of bluish green jade with blackish streaks, with conventionalized animal heads at upper end. Length 8 cm., breadth 2.2 cm. Pl. XLV, Fig. 6. (Cat. No. $\frac{2939}{633}$.)

Celt-shaped, plain amulet of translucent greenish blue jadeite. Length 17.6 cm., breadth 2.8 cm. Pl. XLV, Fig. 7. (Cat. No. $\frac{2939}{892}$.)

Triangular amulet of bright green, white mottled jade. Length 3.4 cm., breadth 1.8 cm. Pl. XLV, Fig. 8. (Cat. No. $\frac{2939}{12880}$.)

Nearly leaf-shaped, plain amulet, thin and flat, of translucent, greenish blue jadeite. Length 5.8 cm., breadth 2.6 cm. Pl. XLV, Fig. 9. (Cat. No. $\frac{2939}{965}$.)

Portion of a plate-like amulet of mottled pale green jade, adorned with low relief figures of two human faces with head-dresses and ear ornaments; the one seen "en face" forming the center of the plate, the other being sculptured in profile on its left border. The portion to the right is broken off. This specimen is undoubtedly of extraneous origin, obtained by the Indians from some northern source. Length 5.8 cm., breadth 4.6 cm. Pl. XLV, Fig. 10. (Cat. No. $\frac{2939}{1628}$.)

Plain, celt-shaped amulet of yellowish green jadeite. Length 6.3 cm., breadth 1.5 cm. Pl. XLV, Fig. 11. (Cat. No. $\frac{2939}{926}$.)

Diminutive celt-shaped amulet of greenish blue jadeite, adorned with an incised conventionalized animal or human figure. Length 2.6 cm., breadth 0.9 cm. Pl. XLV, Fig. 12. (Cat. No. $\frac{2939}{556}$.)

Small, oblong plain pendant of greenish jadeite. Length 2.6 cm., breadth 0.9 cm. Pl. XLV, Fig. 13. (Cat. No. $\frac{2939}{1008}$.)

Celt-shaped, plain amulet of translucent, greenish jadeite. Length 5.3 cm., breadth 1.2 cm. Pl. XLV, Fig. 14. (Cat. No. $\frac{2939}{970}$.)

Amulet, head of bird (?), of mottled bluish saussurite with white band. Length 3.4 cm., breadth 2.4 cm. Pl. XLV, Fig. 15. (Cat. No. $\frac{2939}{1294}$.)

Celt-shaped amulet of greenish gray stone, with an incised band at the upper end. Length 3.4 cm., breadth 2 cm. Pl. XLV, Fig. 16. (Cat. No. $\frac{2939}{649}$.)

Plain, celt-shaped amulet of greenish yellow stone. Length 5.7 cm., breadth 1.5 cm. Pl. XLV, Fig. 17. (Cat. No. $\frac{2939}{969}$.)

Oblong, cylindrical bead of greenish blue saussurite. Length 2.7 cm., diameter 1.3 cm. Pl. XLV, Fig. 18. (Cat. No. $\frac{2939}{1618}$.)

Oblong, cylindrical bead of greenish blue saussurite. Length 2.2 cm., diameter 1.2 cm. Pl. XLV, Fig. 19. (Cat. No. $\frac{2939}{1620}$.)

Oblong, cylindrical bead of greenish blue saussurite. Length 1.7 cm., diameter 1.2 cm. Pl. XLV, Fig. 20. (Cat. No. $\frac{2939}{1619}$.)

Celt-shaped amulet, flat and thin, of translucent, greenish blue jadeite. Length 5.8 cm., breadth 1.3 cm. Pl. XLV, Fig. 21. (Cat. No. $\frac{2939}{968}$.)

Plain, celt-shaped amulet of greenish blue translucent jadeite. Length 3.9 cm., breadth 1 cm. Pl. XLV, Fig. 22. (Cat. No. $\frac{2939}{999}$.)

Small pendant of greenish blue jadeite, with an incised band at the upper end. Length 2.3 cm., breadth 1 cm. Pl. XLV, Fig. 23. (Cat. No. $\frac{2939}{255}$.)

Amulet of greenish blue saussurite representing an animal with upturned tail. Length 2.9 cm., breadth 2.1 cm. Pl XLV, Fig. 24. (Cat. No. $\frac{2939}{1208}$.)

Tube of mottled greenish gray jadeite, squared cylindrical, with three encircling band ornaments. Length 8.4 cm., breadth 1.3 cm. Pl. XLV, Fig. 25. (Cat. No. $\frac{2939}{1404}$.)

Amulet of white mottled greenish blue saussurite, representing an animal. Length 2.6 cm., height 1.4 cm. Pl. XLV, Fig 26. (Cat. No. $\frac{2939}{1289}$.)

Small curved pendant of translucent greenish jadeite. Length 1.8 cm., breadth 0.8 cm. Pl. XLV, Fig. 27. (Cat. No. $\frac{2939}{1014}$.)

Objects of Jade from Mexico.

The specimens here reproduced for comparison are from the state of Oaxaca. They were obtained from Dr. Carl Lumholtz and other collectors and were loaned me for reproduction by Mr. George G. Heye of New York City. Of these specimens the figurines represented in the three top rows of Pl. XLVI, show the structural shape of the mineral. The natives have simply taken advantage of the natural jade parellelograms and used two sides as a face for the carving of the human figures. Only a small number of specimens have the back rounded or flattened. All have suspension holes bored sideways. The following objects are illustrated.

Amulet of greenish white jadeite, representing a human figure in sitting position. Height 4.8 cm., breadth 1.9 cm. Pl. XLVI, Fig. 1.

Amulet of greenish white jadeite, representing a sitting human figure. Height 4.6 cm., breadth 2 cm. Pl. XLVI, Fig. 2.

Amulet of greenish white jadeite, representing a sitting human figure. Height 4.3 cm., breadth 2.3 cm. Pl. XLVI, Fig. 3.

Amulet of greenish jadeite, representing a sitting human figure. Height 4.2 cm., breadth 2.3 cm. Pl. XLVI, Fig. 4.

Amulet of greenish white jadeite, back flat, representing sitting human figure. Height 3.8 cm., breadth 2 cm. Pl. XLVI, Fig. 5.

Amulet of greenish white jadeite, back flat, representing sitting human figure. Height 3.2 cm., breadth 1.9 cm. Pl. XLVI, Fig. 6.

Amulet of greenish white jadeite, representing sitting human figure. Height 3.8 cm., breadth 1.5 cm. Pl. XLVI, Fig. 7.

Amulet of light green, translucent jadeite, representing sitting human figure. Height 4.4 cm., breadth 1.8 cm. Pl. XLVI, Fig. 8.

Amulet of light green, translucent jadeite, representing sitting human figure, back flat. Height 4.7 cm., breadth 2.1 cm. Pl. XLVI, Fig. 9.

Amulet of light green, translucent jadeite, representing sitting human figure. Height 4.2 cm., breadth 1.8 cm. Pl. XLVI, Fig. 10.

Amulet of light green, translucent jadeite, representing sitting human figure, back nearly flat. Height 2.6 cm., breadth 1.4 cm. Pl. XLVI, Fig. 11.

Amulet of light green, translucent jadeite, representing a sitting human figure, back flat. Height 2.9 cm., breadth 1.2 cm. Pl. XLVI, Fig. 12.

Amulet, small human head, of light green jadeite. Height 1.3 cm., breadth 1.4 cm. Pl. XLVI, Fig. 13.

Amulet of light green jadeite, human figure. Height 2.7 cm., breadth 1.3 cm. Pl. XLVI, Fig. 14.

Amulet of green jadeite, human head. Height 3 cm., breadth 2.7 cm. Pl. XLVI, Fig. 15.

Amulet, human figure, of greenish gray jadeite. Height 2.7 cm., breadth 1.7 cm. Pl. XLVI, Fig. 16.

Amulet of greenish white jadeite, human head. Height 2.3 cm., breadth 1.8 cm. Pl. XLVI, Fig. 17.

Rectangular amulet of green jadeite, plain, flat and thin. Height 2.1 cm., breadth 1.7 cm. Pl. XLVI, Fig. 18.

Amulet of greenish white jadeite, representing an animal. Height 1.8 cm., breadth 2.7 cm. Pl. XLVI, Fig. 19.

Button-like, flat, rectangular piece of greenish jadeite. Height 2.1 cm., breadth 1.7 cm. Pl. XLVI, Fig. 20.

Square ear or lip ornament of translucent, light green jadeite. Height 3 cm., breadth 3.1 cm. Pl. XLVI, Fig. 21.

Amulet of greenish gray jadeite, representing human head. Height 3.1 cm., breadth 2.5 cm. Pl. XLVI, Fig. 22.

Oblong, cylindrical bead of green jadeite. Length 2.6 cm., diameter 1.7 cm. Pl. XLVI, Fig. 23.

Nearly globular bead of greenish gray jadeite. Diameter 1.7 cm. Pl. XLVI, Fig. 24.

Amulet of greenish gray jadeite, flat, thin and rectangular, representing a human figure. Height 4.9 cm., breadth 2.1 cm. Pl. XLVI, Fig. 25.

Oblong, cylindrical bead of green mottled jadeite. Length 2.5 cm., diameter 1.7 cm. Pl. XLVI, Fig. 26.

Amulet of greenish gray jadeite, flat and thin, representing human head ornamented with head-dress. Height 3 cm., breadth 2 cm. Pl. XLVI, Fig. 27.

Amulet of greenish white jadeite, flat and thin, representing human head. Height 3.5 cm., breadth 2.7 cm. Pl. XLVI, Fig. 28.

Claw-shaped amulet or pendant of mottled, greenish white jadeite. Height 4.4 cm., breadth 1.7 cm. Pl. XLVI, Fig. 29.

Claw-shaped amulet or pendant of mottled greenish white jadeite. Height 3.2 cm., breadth 1.3 cm. Pl. XLVI, Fig. 30.

Claw-shaped amulet or pendant of mottled greenish white jadeite. Height 2.6 cm., breadth 1.1 cm. Pl. XLVI, Fig. 31.

Oblong, cylindrical bead of mottled whitish green jadeite. Length 2 cm., diameter 1.8 cm. Pl. XLVI, Fig. 32.

Thin, flat bead of mottled whitish green jadeite. Diameter 1.8 cm., thickness 0.3 cm. Pl. XLVI, Fig. 33.

Thin, flat, circular bead of mottled whitish green jadeite. Diameter 1.2 cm., thickness 0.2 cm. Pl. XLVI, Fig. 34.

Cylindrical tube of greenish white jadeite, widening towards both ends. Length 2.1 cm., diameter 1.1 cm. Pl. XLVI, Fig. 35.

Cylindrical tube of greenish white jadeite. Length 3.7 cm., diameter 1.1 cm. Pl. XLVI, Fig. 36.

Pendant, bell-shaped, flat and thin, of greenish white jadeite. Height 2.5 cm., breadth 1.8 cm. Pl. XLVI, Fig. 37.

Pendant of translucent, green jadeite adorned with vertical parallel incisions at the lower end. Height 1.6 cm., breadth 1.3 cm. Pl. XLVI, Fig. 38.

Recapitulation.

The collections made at Las Guacas show that in this region the art of the stonecutter and polisher had reached a remarkably advanced stage of development.

If we compare these stone artefacts with similar vestiges of the art of the mainland of Costa Rica, more especially with the relics of the culture of the Güetares of the Atlantic coast and the highlands (the Pacific slope and coastland are as yet almost unexplored) we observe, as already pointed out, not only marked differences in general shape and in ornamentation, but that several entire groups of stone artefacts are limited almost exclusively to one region, while missing in the other, a few stray objects alone excepted. We search in vain in the upland regions for most of

the above described groups of "Las Guacas" stone artefacts, such as the small celt-shaped, polished amulets of jade and other decorative stones, the tubes, ear-plugs, most of the small objects of personal adornment, the biomorphic ceremonial clubs, the large double-bladed sharp-edged axes, the bark-scrapers, and the beautiful, high-legged metates with curved plate and artistic ornamentation.

In both the regions here contrasted the art of the sculptor in basaltic lava, the stone selected for the manufacture of household and ceremonial objects of larger size, has left numerous highly creditable examples of his work, although differing in character and conception. On the other hand the special art of the manufacture and polishing of precious or decorative stones to be worn as amulets or ornaments is almost exclusively limited to the Las Guacas culture, which in consequence has attained a many-sided development. The few amulets and beads of stone occasionally encountered in the graves of the Güetares are probably all of Nicoyan origin.

While the sculptor in basalt in Nicoya devoted most of his attention to metates and their ornamentation, the skill of the highlander brought forth a large group of related objects, generally so-called "stools," either provided with an oval plate and four legs representing a jaguar, or with a circular plate, with annular base often composed of the figures of monkeys. The Güetares produced numerous stone idols in human shape, varying in height, even reaching full life size, as well as human heads of stone with flat bases. The latter they deposited in the graves. In Nicoya stone idols are of rare occurrence and are quite different in shape. No stone heads of this type have been found on the peninsula. Almost the only artefacts of stone in the two regions which show similarity are the smaller stone celts of the type illustrated in this memoir. The celts of black aphanite typical of the highlands and having a diamond-shaped section do not occur in Nicoya.

The generally close relationship between the culture of the Chiriquians of Columbia and the Güetares has long ago been pointed out by Professor W. H. Holmes. The similarity is especially striking in the stone objects brought to light. Having had the opportunity to compare the vast archeological material of the National Museum of Costa Rica and of the private collections of the same country with the extensive collection of material from Chiriqui in the Yale University Museum and in the National Museum in Washington I find that the principal stone artefacts appear, as a rule, to be almost identical in form. The idols, however, plainly differ in several respects. On the other hand the Chiriquian collections contain whole groups of ceramic artefacts of a superior character and not found in the territories of the Güetares.

The Las Guacas culture appears to be a local development with many peculiar

traits. The limits of its extension are not as yet known, but it is probably restricted to the peninsula of Nicoya, the islands of the bay and the adjoining part of the Pacific slope of Nicaragua. The archeology of the Atlantic side of Nicaragua unfortunately is still on the whole a *terra incognita.*

Certain features of the art of the stone-cutter and the methods of work here in vogue, such as the extensive manufacture of stone amulets, and the employment of the tubular drill in the manufacture of ornamental and ceremonial objects of hard and precious stones, exactly as among the ancient inhabitants of Mexico, plainly point to a northern origin of the Nicoyan culture. Further south on the whole isthmus no similar art products are met with. In the superb collection of Chiriquian art-products in the Yale University Museum there is only a single amulet of stone, a small celt-shaped object, undoubtedly of Nicoyan origin. The "Las Guacas" culture presumably represents the result of the blending of the artistic genius of the conquering Mexican colonies with that of peoples already previously located in these parts. Only through future long-continued detailed and systematic explorations in these regions as well as through much needed investigation of the treasures of the ancient burial-grounds of adjoining territories, as well as those of Chiapas and other South-Mexican states can this and other related archeological questions be ultimately settled.

The striking similarity between the stone metates of these parts and the stools of the West Indian Islands as shown by Dr. O. T. Mason and Dr. W. J. Fewkes has been referred to above.

The best preserved class of ancient artefacts of the Las Guacas culture are the stone objects, which have been described in these pages.

Of ceramic material from Las Guacas there unfortunately exist no authentic specimens except the small number of objects obtained during my own work on the spot and a very large number of small and diminutive globular pots purchased from Velasco. According to Velasco as well as Carillo and other men, who had carried on former excavations, the great majority of the large clay vessels in this burial-ground had been crushed by the pressure of the soil or had fallen to pieces when unearthed. No effort was made to keep together the pieces of a vessel which had fallen apart. In consequence only a very few larger vessels were preserved from this place and these were later on mixed up with pottery from other localities. Many decorated vases, I was informed had been found here, but generally the paintings on account of the long contact with the soil were obliterated or scaled off after exposure to the air.

During my archeological investigations covering seven months in the immediate

neighborhood of Las Guacas as well as in other localities in Nicoya and on the islands of the Gulf I procured at several burial-grounds valuable material representing the same culture and these finds include a considerable number of earthen vessels of various forms and decorative features besides the above mentioned small globular vessels.

In a second memoir it is my hope to make use of these discoveries and to supplement them with illustrations and descriptions of a selection of the most interesting and remarkable specimens of pottery in the Velasco collection from various localities on the same peninsula. The comparatively few archeological objects of gold, copper, bone, shell, and other material preserved from these parts will also receive due attention.

EXPLANATION OF PLATE I.

PAGE.

FIG. 1. Celt-shaped amulet of stone. — ($\frac{1}{2}$). (Cat. No. $\frac{2\,7\,9\,3}{8\,4}$) 33

FIG. 2. Celt-shaped amulet of stone. — ($\frac{1}{2}$). (Cat. No. $\frac{2\,7\,9\,3}{8\,3}$) 33

FIG. 3. Bird's head of stone. — ($\frac{1}{1}$). (Cat. No. $\frac{2\,7\,9\,3}{9\,9}$) 35

FIG. 4. Bird's head of stone. — ($\frac{1}{1}$). (Cat. No. $\frac{2\,7\,9\,3}{9\,8}$) 35

FIG. 5. Celt-shaped amulet of stone. — ($\frac{1}{1}$). (Cat. No. $\frac{2\,7\,9\,3}{8\,7}$) 33

FIG. 6. Celt-shaped amulet of stone. — ($\frac{1}{1}$). (Cat. No. $\frac{2\,7\,9\,3}{9\,5}$) 34

FIG. 7. Celt-shaped amulet of stone. — ($\frac{1}{1}$). (Cat. No. $\frac{2\,7\,9\,3}{8\,6}$) 33

FIG. 8. Celt-shaped amulet of stone. — ($\frac{1}{2}$). (Cat. No. $\frac{2\,7\,9\,3}{8\,5}$) 33

FIG. 9. Celt-shaped amulet of stone. — ($\frac{1}{1}$). (Cat. No. $\frac{2\,7\,9\,3}{8\,8}$) 34

FIG. 10. Double-bladed ax of slate. — ($\frac{1}{2}$). (Cat. No. $\frac{2\,7\,9\,3}{8\,2}$) 33

FIG. 11. Celt-shaped amulet of stone. — ($\frac{1}{1}$). (Cat. No. $\frac{2\,7\,9\,3}{9\,7}$) 35

FIG. 12. Bead of stone. — ($\frac{1}{1}$). (Cat. No. $\frac{2\,7\,9\,3}{1\,0\,0}$) 35

FIG. 13. Same bead from opposite side 35

FIG. 14. Celt-shaped amulet of stone. — ($\frac{1}{1}$). (Cat. No. $\frac{2\,7\,9\,3}{9\,6}$) 34

FIG. 15. Celt-shaped amulet of stone. — ($\frac{1}{1}$). (Cat. No. $\frac{2\,7\,9\,3}{9\,3}$) 34

FIG. 16. Celt-shaped amulet of stone. — ($\frac{1}{1}$). (Cat. No. $\frac{2\,7\,9\,3}{9\,4}$) 34

FIG. 17. Celt-shaped amulet of stone. — ($\frac{1}{1}$). (Cat. No. $\frac{2\,7\,9\,3}{9\,2}$) 34

FIG. 18. Celt-shaped amulet of stone. — ($\frac{1}{2}$). (Cat. No. $\frac{2\,7\,9\,3}{9\,0}$) 34

FIG. 19. Celt-shaped amulet of stone. — ($\frac{1}{1}$). (Cat. No. $\frac{2\,7\,9\,3}{9\,1}$) 34

FIG. 20. Celt-shaped amulet of stone. — ($\frac{1}{2}$). (Cat. No. $\frac{2\,7\,9\,3}{8\,9}$) 34

OBJECTS OF STONE EXCAVATED AT LAS GUACAS BY C. V. HARTMAN.

EXPLANATION OF PLATE II.

PAGE.

FIG. 1. Vase of clay. — ($\frac{1}{3}$). (Cat. No. $\frac{27933}{101}$) 35

FIG. 2. Whistle of clay. — ($\frac{1}{1}$). (Cat. No. $\frac{27933}{112}$) 36

FIG. 3. Vessel of clay. — ($\frac{1}{2}$). (Cat. No. $\frac{27933}{104}$) 35

FIG. 4. Vessel of clay. — ($\frac{1}{2}$). (Cat. No. $\frac{27933}{102}$) 35

FIG. 5. Pipe-like object of clay. — ($\frac{1}{1}$). (Cat. No. $\frac{27933}{110}$) 36

FIG. 6. Vessel of clay. — ($\frac{1}{1}$). (Cat. No. $\frac{27933}{107}$) 35

FIG. 7. Vessel of clay. — ($\frac{1}{2}$). (Cat. No. $\frac{27933}{103}$) 35

OBJECTS OF CLAY EXCAVATED AT LAS GUACAS BY C. V. HARTMAN.

EXPLANATION OF PLATE III.

PAGE.

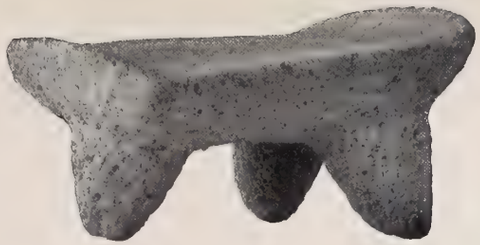
FIG. 1. Metate. — ($\frac{1}{3}$). (Cat. No. $\frac{2}{4}\frac{7}{8}\frac{9}{3}\frac{3}{}$) 26

FIG. 2. Metate. — ($\frac{1}{3}$). (Cat. No. $\frac{2}{4}\frac{7}{7}\frac{9}{3}\frac{3}{}$) 26

FIG. 3. Metate. — ($\frac{1}{5}$). (Cat. No. $\frac{2}{1}\frac{7}{}\frac{9}{}\frac{3}{}$) 16

FIG. 4. Metate. — ($\frac{1}{4}$). (Cat. No. $\frac{2}{5}\frac{7}{}\frac{9}{}\frac{3}{}$) 17

FIG. 5. Metate. — ($\frac{1}{4}$). (Cat. No. $\frac{2}{3}\frac{7}{8}\frac{9}{}\frac{3}{}$) 25



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METATES EXCAVATED AT LAS GUACAS BY C. V. HARTMAN.

EXPLANATION OF PLATE IV.

PAGE.

FIGS. 1, 2. Metate. — ($\frac{1}{4}$). (Cat. No. $\frac{27}{4}\frac{93}{}$) 16

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METATE EXCAVATED AT LAS GUACAS BY C. V. HARTMAN.

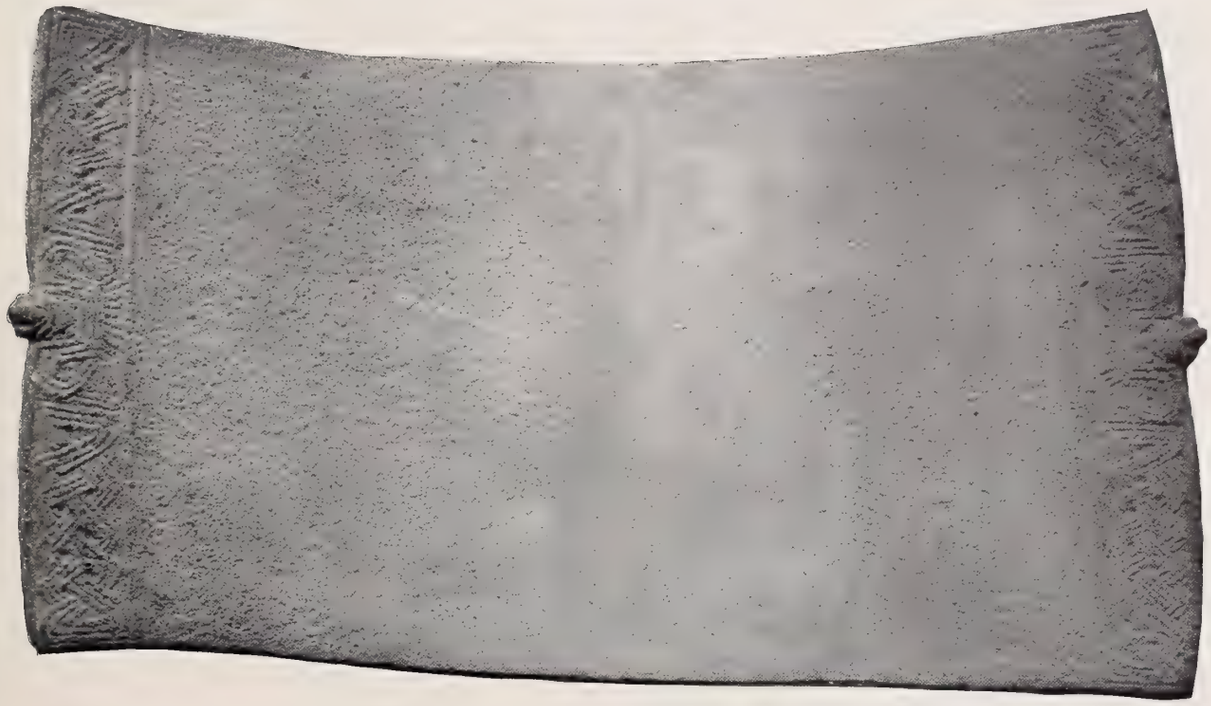
EXPLANATION OF PLATE V.

PAGE.

FIG. 1. Metate. — ($\frac{1}{4}$). (Cat. No. $\frac{2}{4}\frac{7}{9}\frac{9}{3}\frac{3}{2}$) 16

FIG. 2. Rubbing-stone. — ($\frac{1}{4}$). (Stockholm Ethn. Mus.) 48

FIG. 3. Rubbing-stone. — ($\frac{1}{4}$). (Stockholm Ethn. Mus.) 48



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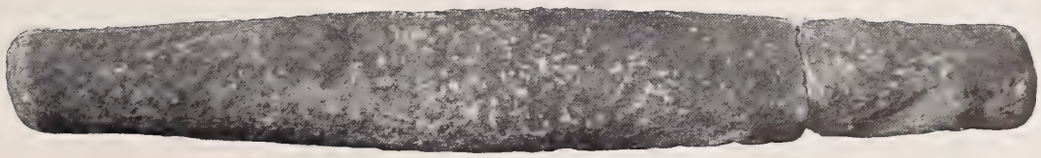

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1. GRINDING SURFACE OF METATE FIGURED ON PLATE IV.
2–3. RUBBING-STONES PRESERVED IN ETHNOGRAPHICAL MUSEUM, STOCKHOLM.

EXPLANATION OF PLATE VI.

PAGE.

FIGS. 1, 2. Metate. — ($\frac{1}{4}$). (Cat. No. $\frac{2\,7\,9\,3}{1\,3}$) 18

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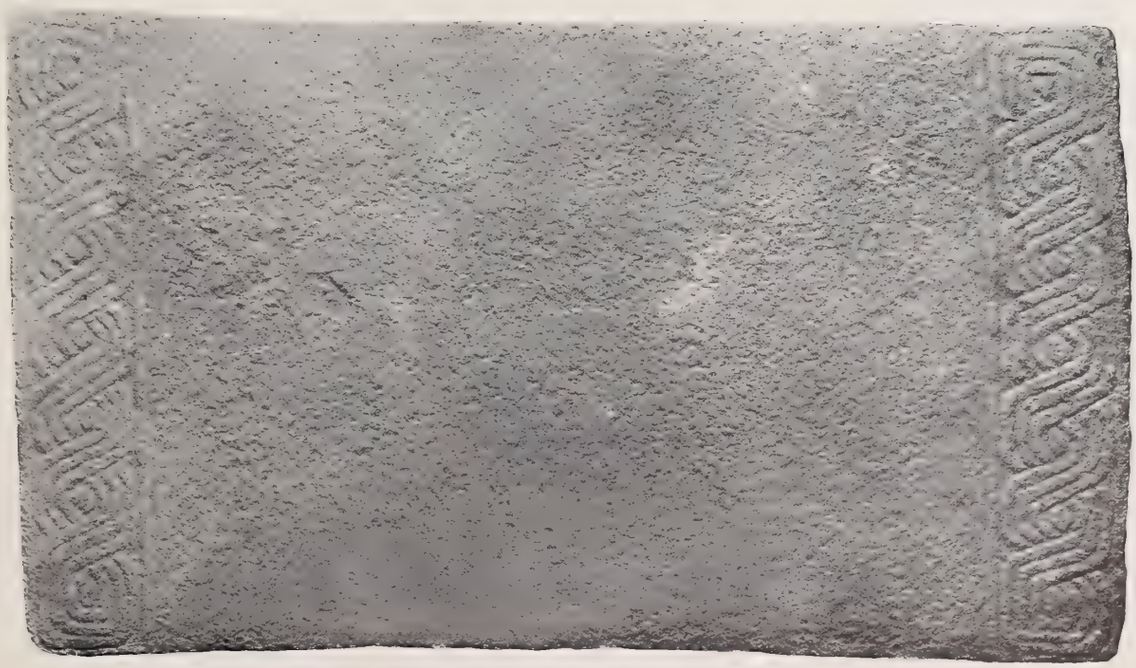

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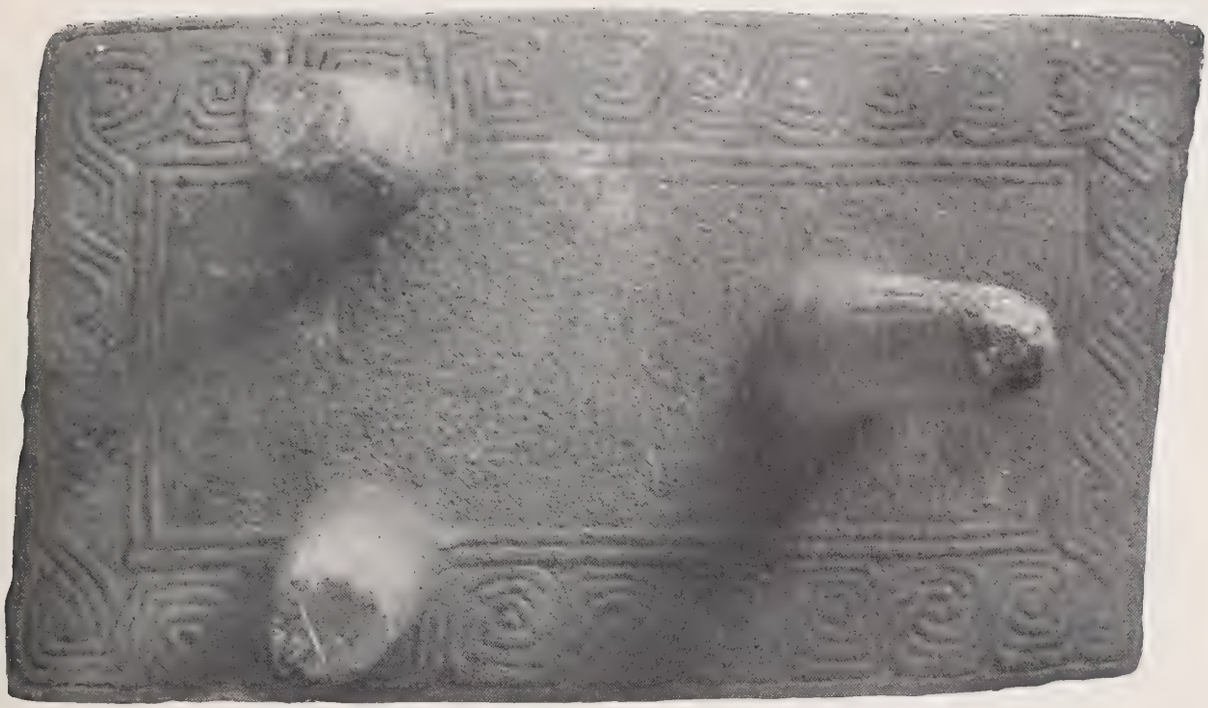
METATE EXCAVATED AT LAS GUACAS BY C. V. HARTMAN.

EXPLANATION OF PLATE VII.

PAGE.

FIG. 1. Metate. — ($\frac{1}{4}$). (Cat. No. $\frac{2}{1}\frac{7}{3}\frac{9}{3}\frac{3}{}$) 18

FIG. 2. Metate. — ($\frac{1}{4}$). (Cat. No. $\frac{2}{1}\frac{7}{1}\frac{9}{1}\frac{3}{}$) 18



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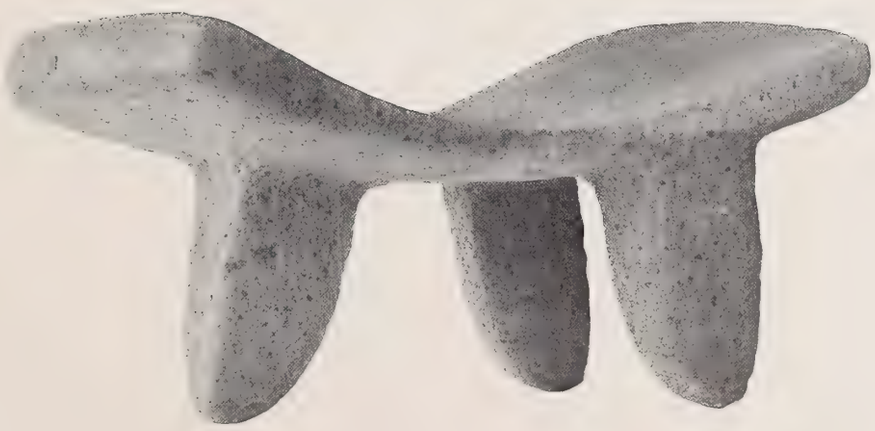

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1. BOTTOM OF METATE FIGURED ON PLATE VI. 2. METATE EXCAVATED AT LAS GUACAS BY C. V. HARTMAN.

EXPLANATION OF PLATE VIII.

PAGE.

FIGS. 1, 2. Metate. — ($\frac{1}{4}$). (Cat. No. $\frac{27}{16}\frac{93}{3}$) 19

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METATE EXCAVATED AT LAS GUACAS BY C. V. HARTMAN.

EXPLANATION OF PLATE IX.

PAGE.

FIGS. 1, 2, 3, 4. Metate. — ($\frac{1}{4}$). (Cat. No. $\frac{27938}{24}$) 22

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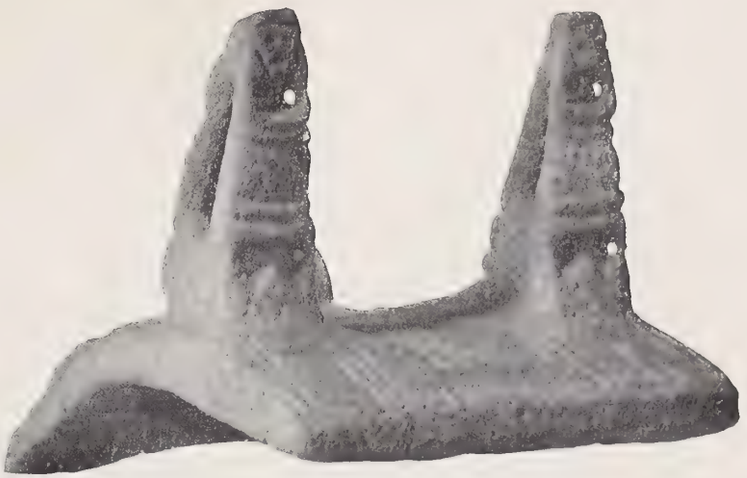

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METATE EXCAVATED AT LAS GUACAS BY C. V. HARTMAN.

EXPLANATION OF PLATE X.

PAGE.

FIGS. 1, 2. Metate. — ($\frac{1}{8}$). (Cat. No. $\frac{2}{8}\frac{7}{1}\frac{9}{9}\frac{3}{3}$) 33

FIGS. 3, 4. Metate. — ($\frac{1}{6}$). (Stockholm Ethn. Mus.) 44

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1–2. METATE EXCAVATED AT LAS GUACAS BY C. V. HARTMAN.
3–4. METATE FROM LAS GUACAS IN ETHNOGRAPHICAL MUSEUM, STOCKHOLM.

EXPLANATION OF PLATE XI.

PAGE.

FIG. 1. Metate. — ($\frac{1}{6}$). (Stockholm Ethn. Mus.) 44

FIGS. 2, 3, 4. Metate. — ($\frac{1}{6}$). (Stockholm Ethn. Mus.) 44

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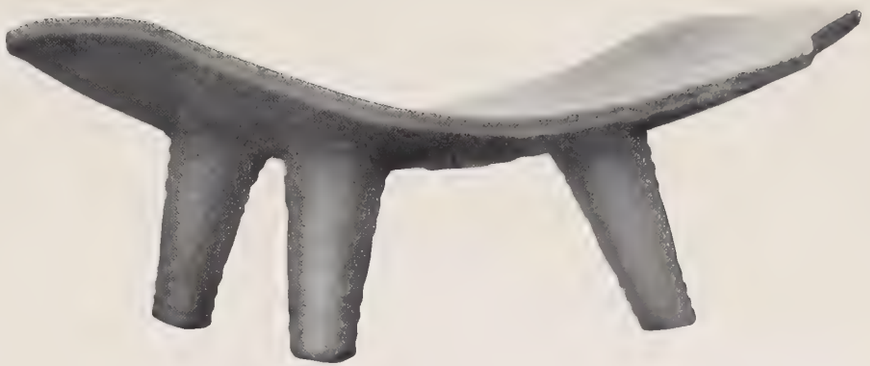

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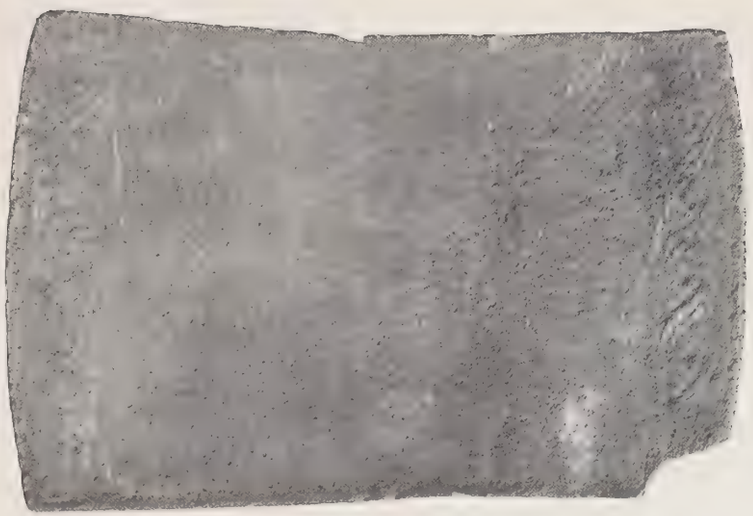

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1. GRINDING SURFACE OF METATE FIGURED ON PLATE X, FIGS. 3 AND 4.
2–4. METATE FROM LAS GUACAS PRESERVED IN ETHNOGRAPHICAL MUSEUM, STOCKHOLM.

EXPLANATION OF PLATE XII.

PAGE.

FIGS. 1, 2. Metate.—($\frac{1}{5}$). (Cat. No. $\frac{2}{3}\frac{9}{4}\frac{3}{3}\frac{9}{1}$) 44

FIGS. 3, 4. Metate.—($\frac{1}{5}$). (Cat. No. $\frac{2}{1}\frac{4}{4}\frac{3}{1}\frac{8}{3}$) 45

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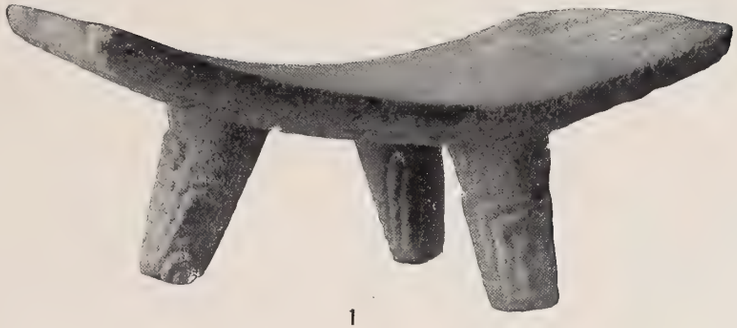
METATES FROM LAS GUACAS IN THE VELASCO COLLECTIONS OF THE CARNEGIE MUSEUM.

EXPLANATION OF PLATE XIII.

PAGE.

FIGS. 1, 2. Metate. — ($\frac{1}{4}$). (Cat. No. $\frac{2}{1}\frac{4}{4}\frac{3}{1}\frac{8}{2}$) 45

FIGS. 3, 4. Metate. — ($\frac{1}{4}$). (Cat. No. $\frac{2}{1}\frac{4}{4}\frac{3}{1}\frac{8}{1}$) 45



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METATES FROM LAS GUACAS IN THE VELASCO COLLECTIONS OF THE CARNEGIE MUSEUM.

EXPLANATION OF PLATE XIV.

PAGE.

FIGS. 1, 2. Metate.—($\frac{1}{6}$). (Cat. No. $\frac{2}{3}\frac{9}{4}\frac{3}{3}\frac{9}{0}$) 45

FIGS. 3, 4. Metate.—($\frac{1}{6}$). (Cat. No. $\frac{2}{3}\frac{9}{4}\frac{3}{2}\frac{9}{9}$) 45

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METATES FROM LAS GUACAS IN THE VELASCO COLLECTIONS OF THE CARNEGIE MUSEUM.

EXPLANATION OF PLATE XV.

PAGE.

FIGS. 1, 2, 3, 4. Metate.—($\frac{1}{4}$). (Cat. No. $\frac{24}{14}\frac{38}{10}$) 45

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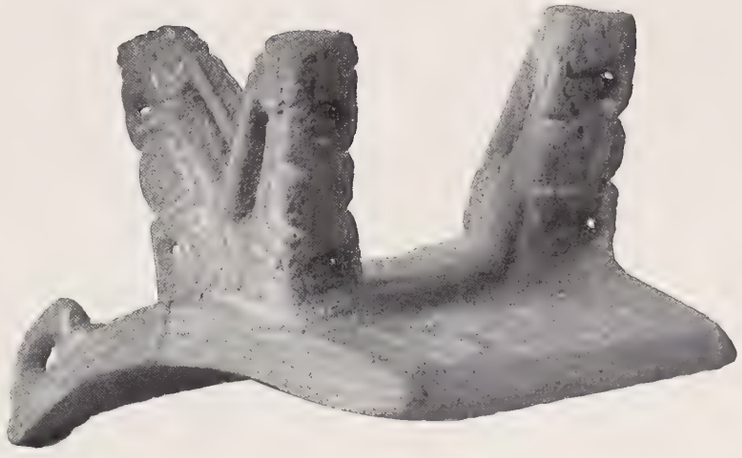

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METATES FROM LAS GUACAS IN THE VELASCO COLLECTIONS OF THE CARNEGIE MUSEUM.

EXPLANATION OF PLATE XVI.

PAGE.

FIGS. 1, 2, 3, 4. Metate.—($\frac{1}{5}$). (Cat. No. $\frac{2}{3}\frac{9}{4}\frac{3}{2}\frac{9}{8}$) 46

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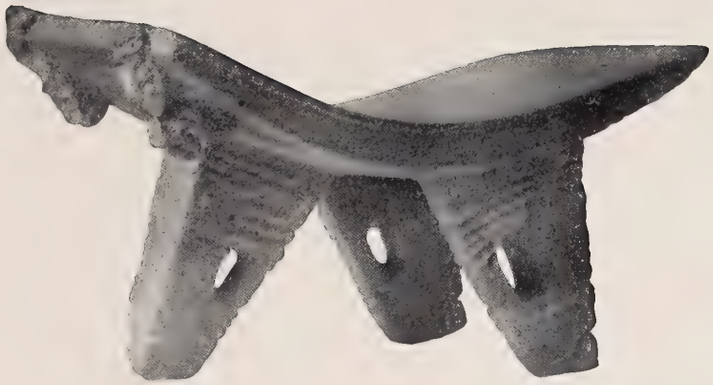
METATES FROM LAS GUACAS IN THE VELASCO COLLECTIONS OF THE CARNEGIE MUSEUM.

EXPLANATION OF PLATE XVII.

PAGE.

FIGS. 1, 2. Metate.—($\frac{1}{4}$). (Cat. No. $\frac{24380}{149}$) 46

FIGS. 3, 4. Metate.—($\frac{1}{4}$). (Cat. No. $\frac{29392}{3427}$) 46



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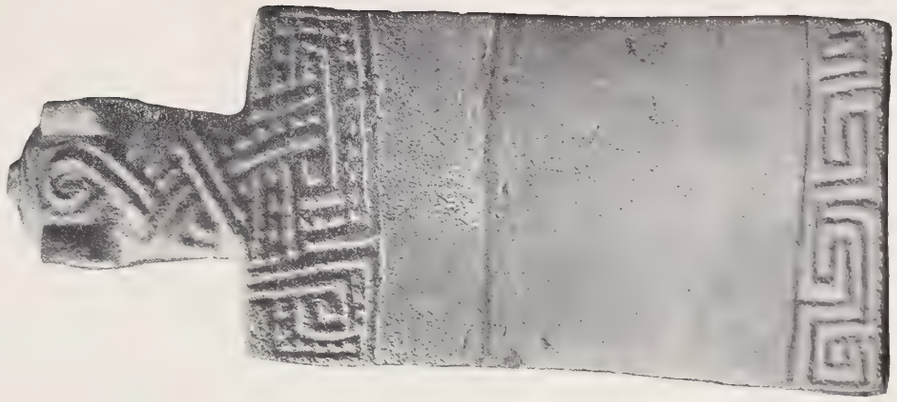

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METATES FROM LAS GUACAS IN THE VELASCO COLLECTIONS OF THE CARNEGIE MUSEUM.

EXPLANATION OF PLATE XVIII.

PAGE

FIGS. 1, 2, 3. Metate. — ($\frac{1}{6}$). (Nat. Mus. of Costa Rica) 46

FIG. 4. Metate. — ($\frac{1}{6}$). (Nat. Mus. of Costa Rica) 46

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METATES FROM LAS GUACAS IN THE VELASCO COLLECTIONS OF THE NATIONAL MUSEUM OF COSTA RICA.

EXPLANATION OF PLATE XIX.

PAGE.

FIG. 1. Metate. — ($\frac{1}{4}$). (Nat. Mus. of Costa Rica) 47

FIGS. 2, 3, 4. Metate. — ($\frac{1}{5}$). (Cat. No. $\frac{24388}{14088}$) 47

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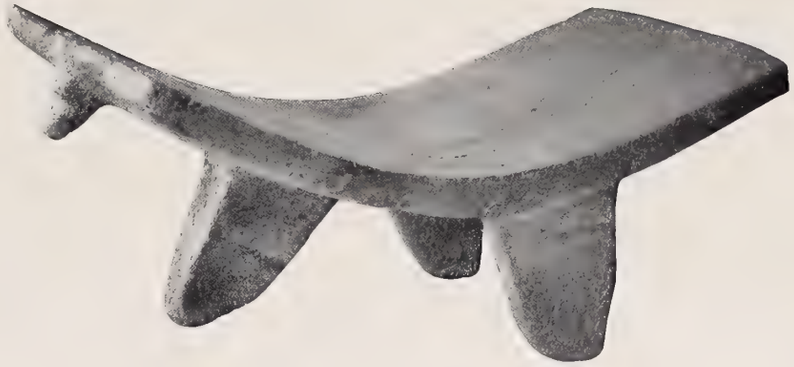

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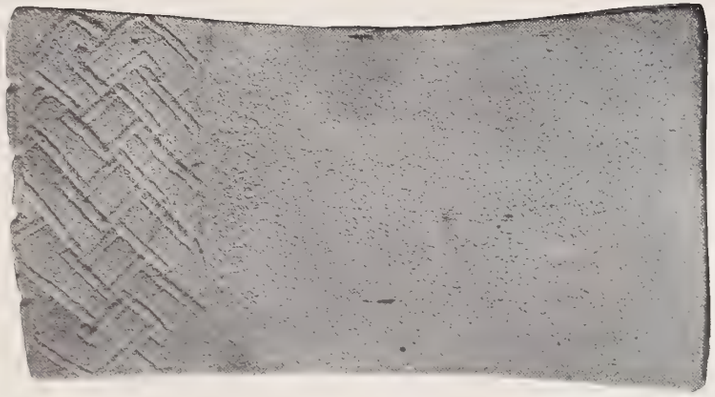

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1. METATE FROM LAS GUACAS IN THE NATIONAL MUSEUM OF COSTA RICA.
2–4. METATE FROM LAS GUACAS IN THE VELASCO COLLECTIONS OF THE CARNEGIE MUSEUM.

EXPLANATION OF PLATE XX.

PAGE.

FIGS. 1, 2. Metate. — ($\frac{1}{5}$). (Cat. No. $\frac{2}{3}\frac{9}{4}\frac{3}{2}\frac{9}{6}$) 47

FIGS. 3, 4. Metate. — ($\frac{1}{5}$). (Cat. No. $\frac{2}{3}\frac{9}{4}\frac{3}{2}\frac{9}{5}$) 47

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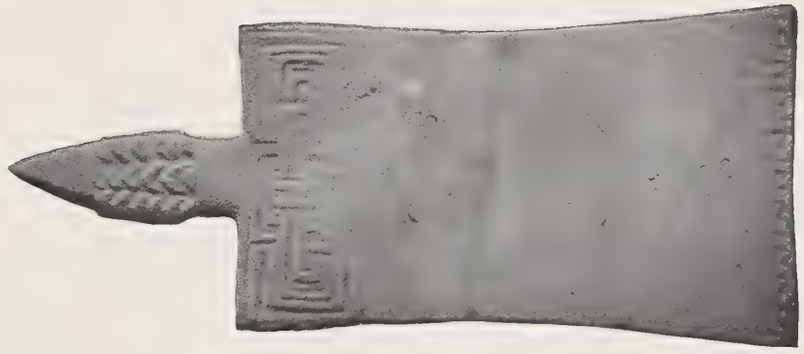

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METATES FROM LAS GUACAS IN THE VELASCO COLLECTIONS OF THE CARNEGIE MUSEUM.

EXPLANATION OF PLATE XXI.

PAGE.

Metates in use to-day amongst the Talamanca Indians of Costa Rica 42

Photo by Rudd & Paynter, San José.

METATES IN USE TO-DAY AMONG THE TALAMANCA INDIANS OF COSTA RICA.

EXPLANATION OF PLATE XXII.

PAGE.

FIG. 1. Rubbing-stone. — ($\frac{1}{2}$). (Cat. No. $\frac{24384}{14044}$) 48

FIG. 2. Rubbing-stone. — ($\frac{1}{2}$). (Nat. Mus. of Costa Rica) 48

FIG. 3. Rubbing-stone. — ($\frac{1}{2}$). (Nat. Mus. of Costa Rica) 48

FIG. 4. Rubbing-stone. — ($\frac{1}{2}$). (Nat. Mus. of Costa Rica) 48

FIG. 5. Rubbing-stone. — ($\frac{1}{2}$). (Cat. No. $\frac{29392}{34222}$) 49

FIG. 6. Rubbing-stone. — ($\frac{1}{2}$). (Cat. No. $\frac{24382}{14022}$) 48

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RUBBING-STONES FROM LAS GUACAS CONTAINED IN THE VELASCO COLLECTIONS OF THE CARNEGIE MUSEUM AND THE NATIONAL MUSEUM OF COSTA RICA.

EXPLANATION OF PLATE XXIII.

PAGE.

FIG. 1. Celt. — ($\frac{1}{2}$). (Cat. No. $\frac{2\,9\,3\,9}{1\,1}$) 50

FIG. 2. Celt. — ($\frac{1}{2}$). (Cat. No. $\frac{2\,9\,3\,9}{5}$) 50

FIG. 3. Celt. — ($\frac{1}{2}$). (Cat. No. $\frac{2\,9\,3\,9}{1}$) 50

FIG. 4. Celt. — ($\frac{1}{2}$). (Cat. No. $\frac{2\,9\,3\,9}{2\,7}$) 50

FIG. 5. Celt. — ($\frac{1}{2}$). (Cat. No. $\frac{2\,9\,3\,9}{2\,4}$) 50

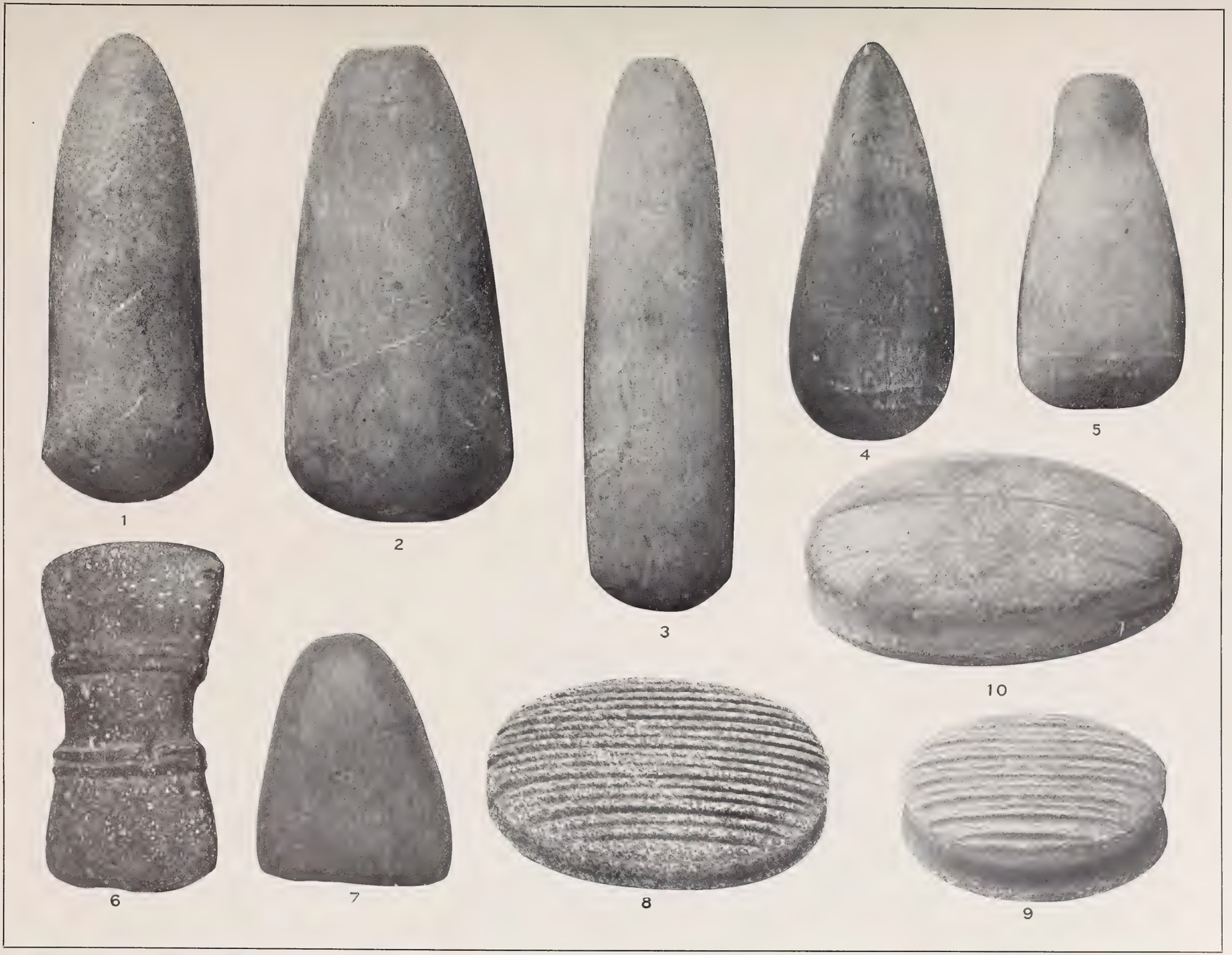
FIG. 6. Ax. — ($\frac{1}{2}$). (Cat. No. $\frac{2\,9\,3\,9}{6\,8}$) 51

FIG. 7. Celt. — ($\frac{1}{2}$). (Cat. No. $\frac{2\,7\,9\,3}{3\,3\,1}$) 50

FIG. 8. Barkscraper. — ($\frac{1}{2}$). (Cat. No. $\frac{2\,4\,3\,8}{2\,7\,5}$) 51

FIG. 9. Barkscraper. — ($\frac{1}{2}$). (Cat. No. $\frac{2\,4\,3\,8}{2\,7\,6}$) 51

FIG. 10. Barkscraper. — ($\frac{1}{2}$). (Cat. No. $\frac{2\,9\,3\,9}{7\,7}$) 51



CELTS, BARKSCRAPERS, ETC., FROM LAS GUACAS CONTAINED IN THE VELASCO COLLECTIONS OF THE CARNEGIE MUSEUM.

EXPLANATION OF PLATE XXIV.

PAGE.

FIG. 1. Ax. — ($\frac{1}{2}$). (Cat. No. $\frac{2}{7}\frac{9}{3}\frac{3}{4}\frac{9}{}$) 51

FIG. 2. Ax. — ($\frac{1}{2}$). (Cat. No. $\frac{2}{7}\frac{9}{3}\frac{3}{3}\frac{9}{}$) 51

FIG. 3. Ax. — ($\frac{1}{2}$). (Cat. No. $\frac{2}{7}\frac{9}{3}\frac{3}{2}\frac{9}{}$) 51

FIG. 4. Ax. — ($\frac{1}{2}$). (Cat. No. $\frac{2}{7}\frac{9}{3}\frac{3}{5}\frac{9}{}$) 51

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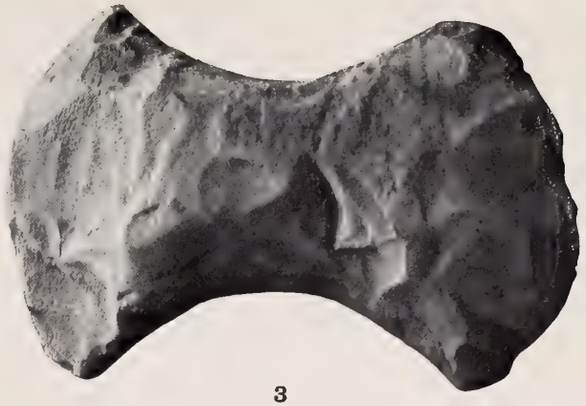

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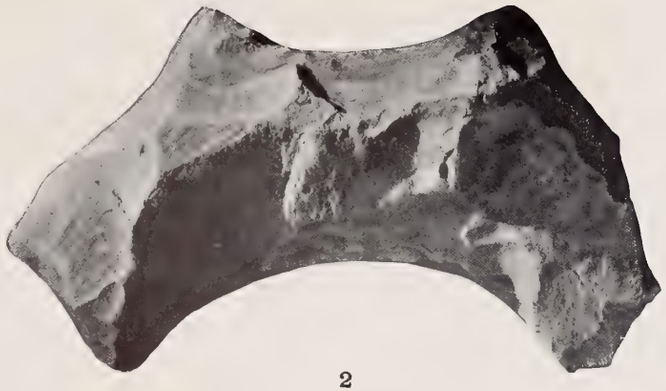

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STONE AXES FROM LAS GUACAS CONTAINED IN THE HARTMAN AND VELASCO COLLECTIONS OF THE CARNEGIE MUSEUM.

EXPLANATION OF PLATE XXV.

PAGE.

FIGS. 1, 2. Club-head. — ($\frac{1}{2}$). (Nat. Mus. of Costa Rica, No. 10966) 55

FIG. 3. Club-head. — ($\frac{1}{1}$). (Cat. No. $\frac{2939}{2\,1\,4}$) 55

FIGS. 4, 5. Club-head. — ($\frac{1}{2}$). (Nat. Mus. of Costa Rica, No. 8923) 55

FIG. 6. Club-head. — ($\frac{1}{1}$). (Cat. No. $\frac{2438}{2\,5\,6}$) 55

FIG. 7. Club-head. — ($\frac{1}{2}$). (Cat. No. $\frac{2939}{2\,1\,3}$) 55

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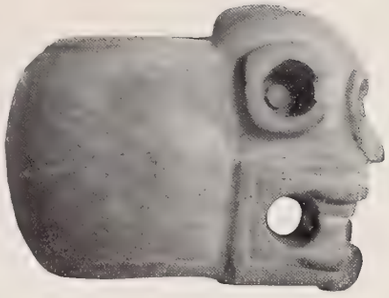

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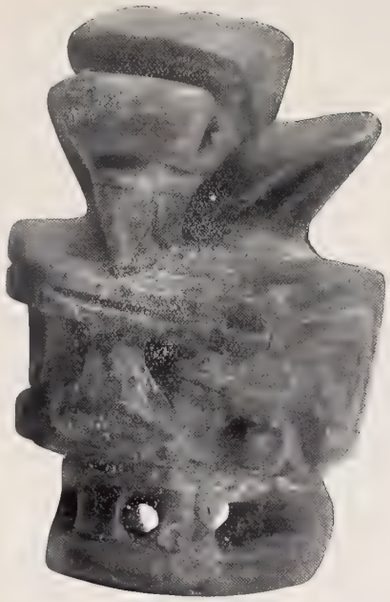

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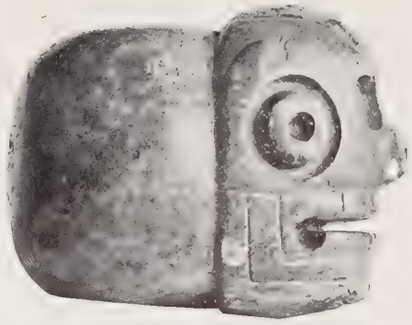

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CLUB-HEADS FROM LAS GUACAS CONTAINED IN THE VELASCO COLLECTIONS OF THE CARNEGIE MUSEUM AND THE NATIONAL MUSEUM OF COSTA RICA.

EXPLANATION OF PLATE XXVI.

PAGE.

FIG. 1. Club-head. — ($\frac{1}{1}$). (Cat. No. $\frac{2}{2}\frac{9}{2}\frac{3}{4}\frac{9}{}$) 56

FIG. 2. Club-head. — ($\frac{1}{2}$). (Nat. Mus. of Costa Rica, No. 3361) 56

FIG. 3. Club-head. — ($\frac{1}{1}$). (Cat. No. $\frac{2}{2}\frac{9}{5}\frac{3}{6}\frac{9}{}$) 56

FIG. 4. Club-head. — ($\frac{1}{2}$). (Nat. Mus. of Costa Rica, No. 8922) 56

FIG. 5. Club-head. — ($\frac{1}{1}$). (Cat. No. $\frac{2}{2}\frac{4}{5}\frac{3}{5}\frac{1}{}$) 56

FIG. 6. Club-head. — ($\frac{1}{2}$). (Nat. Mus. of Costa Rica, No. 8927) 59

FIG. 7. Club-head. — ($\frac{1}{1}$). (Cat. No. $\frac{2}{2}\frac{9}{2}\frac{3}{2}\frac{9}{}$) 56

FIG. 8. Club-head. — ($\frac{1}{2}$). (Nat. Mus. of Costa Rica, No. 9092) 56

FIG. 9. Club-head. — ($\frac{1}{1}$). (Cat. No. $\frac{2}{2}\frac{9}{5}\frac{3}{8}\frac{9}{}$) 59

CLUB-HEADS FROM LAS GUACAS CONTAINED IN THE VELASCO COLLECTIONS OF THE CARNEGIE MUSEUM AND THE NATIONAL MUSEUM OF COSTA RICA.

EXPLANATION OF PLATE XXVII.

PAGE.

FIG. 1. Club-head.—($\frac{1}{1}$). (Cat. No. $\frac{2\,9\,3\,9}{2\,3\,2}$). 57

FIG. 2. Club-head.—($\frac{1}{1}$). (Cat. No. $\frac{2\,9\,3\,9}{2\,2\,7}$). 57

FIG. 3. Club-head.—($\frac{1}{1}$). (Cat. No. $\frac{2\,9\,3\,9}{2\,2\,9}$). 57

FIG. 4. Club-head.—($\frac{1}{1}$). (Cat. No. $\frac{2\,4\,3\,8}{2\,6\,1}$). 57

FIG. 5. Club-head.—($\frac{1}{1}$). (Cat. No. $\frac{2\,9\,3\,9}{2\,3\,0}$). 57

FIG. 6. Club-head.—($\frac{1}{1}$). (Cat. No. $\frac{2\,9\,3\,9}{2\,3\,4}$). 57

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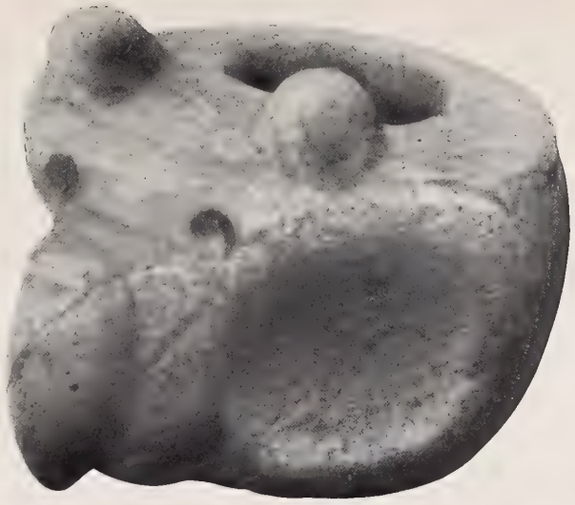

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CLUB-HEADS FROM LAS GUACAS CONTAINED IN THE VELASCO COLLECTIONS OF THE CARNEGIE MUSEUM.

EXPLANATION OF PLATE XXVIII.

PAGE.

FIG. 1. Club-head. — ($\frac{1}{2}$). (Cat. No. $\frac{24388}{26070}$) 58

FIG. 2. Club-head. — ($\frac{1}{2}$). (Cat. No. $\frac{29396}{24646}$) 58

FIGS. 3, 4. Club-head. — ($\frac{1}{2}$) (Cat. No. $\frac{29395}{24645}$) 58

FIG. 5. Club-head. — ($\frac{1}{2}$). (Cat. No. $\frac{29397}{24647}$) 58

FIG. 6. Club-head. — ($\frac{1}{2}$). (Cat. No. $\frac{24388}{27474}$) 58

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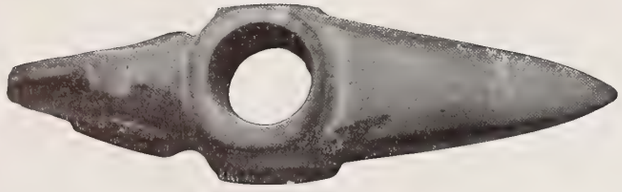

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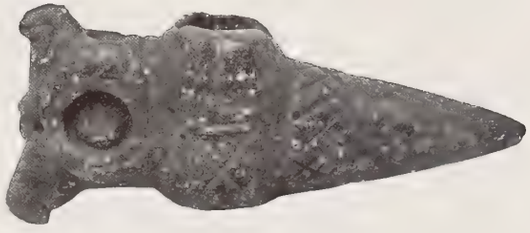

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CLUB-HEADS FROM LAS GUACAS CONTAINED IN THE VELASCO COLLECTIONS OF THE CARNEGIE MUSEUM AND THE NATIONAL MUSEUM OF COSTA RICA.

EXPLANATION OF PLATE XXIX.

PAGE.

FIG. 1. Club-head. — ($\frac{2}{3}$). (Cat. No. $\frac{2}{2}\frac{9}{5}\frac{3}{1}\frac{9}{}$) 58

FIG. 2. Club-head. — ($\frac{1}{2}$). (Cat. No. $\frac{2}{2}\frac{9}{5}\frac{3}{0}\frac{9}{}$) 58

FIG. 3. Club-head. — ($\frac{2}{3}$). (Cat. No. $\frac{2}{2}\frac{9}{5}\frac{3}{2}\frac{9}{}$) 58

FIG. 4. Club-head. — ($\frac{1}{1}$). (Cat. No. $\frac{2}{2}\frac{9}{4}\frac{3}{8}\frac{9}{}$) 58

FIG. 5. Club-head. — ($\frac{1}{2}$). (Nat. Mus. of Costa Rica, No. 8936) 58

FIG. 6. Club-head. — ($\frac{2}{3}$). (Cat. No. $\frac{2}{2}\frac{9}{4}\frac{3}{9}\frac{9}{}$) 59

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CLUB-HEADS FROM LAS GUACAS CONTAINED IN THE VELASCO COLLECTIONS OF THE CARNEGIE MUSEUM AND THE NATIONAL MUSEUM OF COSTA RICA.

EXPLANATION OF PLATE XXX.

PAGE.

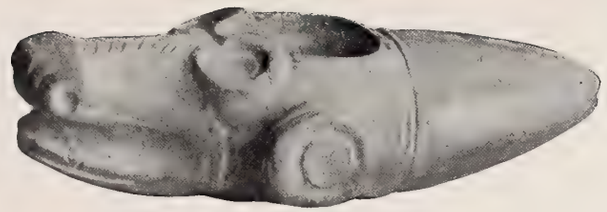
FIGS. 1, 2. Club-head. — ($\frac{1}{2}$). (Nat. Mus. of Costa Rica, No. 8937) 59

FIG. 3. Club-head. — ($\frac{1}{1}$). (Cat. No. $\frac{2}{2}\frac{9}{5}\frac{3}{5}\frac{9}{5}$) 59

FIG. 4. Club-head. — ($\frac{1}{2}$). (Nat. Costa Rica, No. 8942) 59

FIG. 5. Club-head. — ($\frac{2}{3}$). (Cat. No. $\frac{2}{2}\frac{9}{5}\frac{3}{3}\frac{9}{3}$) 59

FIG. 6. Club-head. — ($\frac{1}{2}$). (Nat. Mus. of Costa Rica, No. 8933) 59



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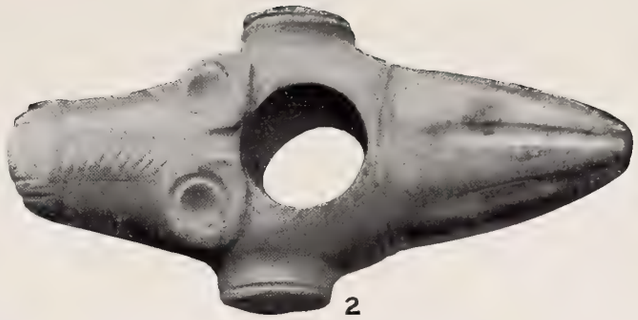

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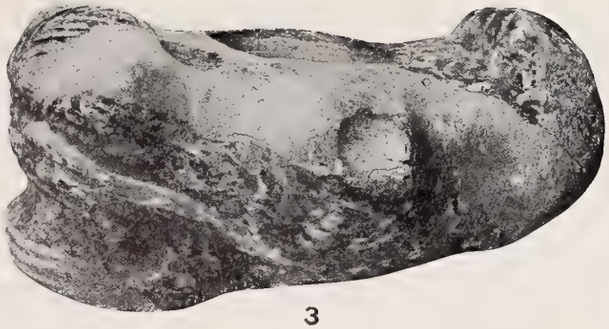

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CLUB-HEADS FROM LAS GUACAS CONTAINED IN THE VELASCO COLLECTIONS OF THE CARNEGIE MUSEUM AND THE NATIONAL MUSEUM OF COSTA RICA.

EXPLANATION OF PLATE XXXI.

PAGE.

FIG. 1. Club-head. — ($\frac{1}{2}$). (Nat. Mus. of Costa Rica, No. 3319) 59

FIG. 2. Club-head. — ($\frac{1}{2}$). (Nat. Mus. of Costa Rica, No. 7564) 59

FIG. 3. Club-head. — ($\frac{1}{1}$). (Nat. Mus. of Costa Rica, No. 7708) 60

FIG. 4. Club-head. — ($\frac{1}{2}$). (Cat. No. $\frac{24384}{2644}$) 60

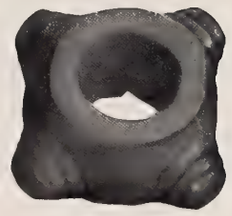
FIG. 5. Club-head. — ($\frac{1}{2}$). (Cat. No. $\frac{24384}{2771}$) 60

FIG. 6. Club-head. — ($\frac{1}{2}$). (Nat. Mus. of Costa Rica, No. 8946) 60

FIG. 7. Club-head. — ($\frac{1}{2}$). (Cat. No. $\frac{29394}{2433}$) 60

FIG. 8. Club-head. — ($\frac{1}{2}$). (Cat. No. $\frac{24384}{2770}$) 60

FIG. 9. Club-head. — ($\frac{1}{2}$). (Cat. No $\frac{24384}{2773}$) 60



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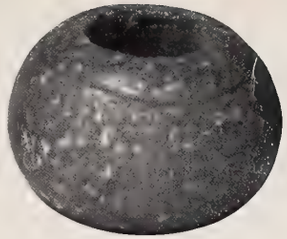

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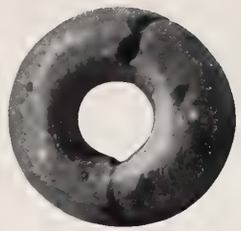

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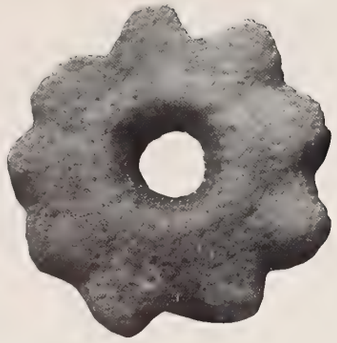

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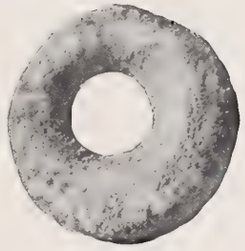

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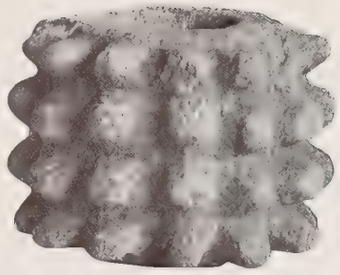

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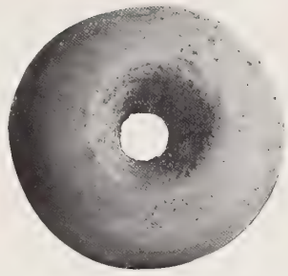

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CLUB-HEADS FROM LAS GUACAS, ETC., CONTAINED IN THE VELASCO COLLECTIONS OF THE CARNEGIE MUSEUM AND THE NATIONAL MUSEUM OF COSTA RICA.

EXPLANATION OF PLATE XXXII.

PAGE.

FIG. 1. Block of jade. — ($\frac{1}{1}$). (Cat. No. $\frac{2}{1}\frac{7}{2}\frac{9}{6}\frac{3}{}$) 46, 52, 86

FIG. 2. Same block from the other side 46, 52, 86

FIG. 3. Block of jade. — ($\frac{1}{1}$). (Cat. No. $\frac{2}{8}\frac{9}{0}\frac{3}{}\frac{9}{}$) 46, 52, 86

FIG. 4. Same block from the other side 46, 52, 86

FIG. 5. Core from a club-head. — ($\frac{1}{1}$). (Cat. No. $\frac{2}{8}\frac{9}{1}\frac{3}{}\frac{9}{}$) 52

FIG. 6. Portion of an animal head. — ($\frac{1}{1}$). (Cat. No. $\frac{2}{1}\frac{7}{2}\frac{9}{7}\frac{3}{}$) 52

FIG. 7. Arrow head. — ($\frac{1}{1}$). (Cat. No. $\frac{2}{4}\frac{4}{1}\frac{3}{}\frac{8}{}$) 52

FIG. 8. Polishing stone. — ($\frac{1}{2}$). (Cat. No. $\frac{2}{4}\frac{4}{4}\frac{3}{}\frac{8}{}$) 52

CORES AND VARIOUS OTHER STONE OBJECTS FROM LAS GUACAS CONTAINED IN THE VELASCO COLLECTIONS OF THE CARNEGIE MUSEUM.

EXPLANATION OF PLATE XXXIII.

PAGE.

FIG. 1. Celt-shaped amulet of stone. — ($\frac{1}{2}$). (Cat. No. $\frac{293939}{315}$) 65, 67

FIG. 2. Celt-shaped amulet of stone. — ($\frac{1}{2}$). (Cat. No. $\frac{293939}{260}$) 65, 67

FIG. 3. Celt-shaped amulet of stone. — ($\frac{1}{2}$). (Cat. No. $\frac{293939}{263}$) 67

FIG. 4. Celt-shaped amulet of stone. — ($\frac{1}{2}$). (Cat. No. $\frac{293939}{320}$) 66, 67

FIG. 5. Celt-shaped amulet of stone. — ($\frac{1}{2}$). (Nat. Mus. of Costa Rica, No. 7851) 66, 67

FIG. 6. Celt-shaped amulet of stone. — ($\frac{1}{2}$). (Cat. No. $\frac{293939}{344}$) 65, 67

FIG. 7. Celt-shaped amulet of stone. — ($\frac{1}{2}$). (Cat. No. $\frac{293939}{484}$) 67

FIG. 8. Celt-shaped amulet of stone. — ($\frac{1}{2}$). (Cat. No. $\frac{243838}{332}$) 67

FIG. 9. Celt-shaped amulet of stone. — ($\frac{1}{2}$). (Cat. No. $\frac{243838}{320}$) 65, 66, 67

FIG. 10. Celt-shaped amulet of stone. — ($\frac{1}{2}$). (Cat. No. $\frac{293939}{324}$) 68

FIG. 11. Celt-shaped amulet of stone. — ($\frac{1}{2}$). (Nat. Mus. of Costa Rica, No. 7805) 68

FIG. 12. Celt-shaped amulet of stone. — ($\frac{1}{2}$). (Cat. No. $\frac{293939}{268}$) 66, 68

FIG. 13. Celt-shaped amulet of stone. — ($\frac{2}{3}$). (Cat. No. $\frac{293939}{355}$) 68

FIG. 14. Celt-shaped amulet of stone. — ($\frac{1}{2}$). (Cat. No. $\frac{293939}{322}$) 68

FIG. 15. Celt-shaped amulet of stone. — ($\frac{1}{2}$). (Cat. No. $\frac{293939}{323}$) 68

FIG. 16. Celt-shaped amulet of stone. — ($\frac{1}{2}$). (Cat. No. $\frac{279938}{128}$) 68

FIG. 17. Celt-shaped amulet of stone. — ($\frac{1}{2}$) (Nat. Mus. of Costa Rica, No. 7731) 68

AMULETS OF STONE FROM LAS GUACAS, CONTAINED IN THE VELASCO COLLECTIONS OF THE CARNEGIE MUSEUM AND THE NATIONAL MUSEUM OF COSTA RICA.

EXPLANATION OF PLATE XXXIV.

PAGE.

FIG. 1. Celt-shaped amulet of stone. — ($\frac{1}{2}$). (Cat. No. $\frac{2438}{278}$) 64, 68

FIG. 2. Celt-shaped amulet of stone. — ($\frac{1}{2}$). (Cat. No. $\frac{2438}{281}$) 68

FIG. 3. Celt-shaped amulet of stone. — ($\frac{1}{2}$). (Cat. No. $\frac{2939}{314}$) 64, 68

FIG. 4. Celt-shaped amulet of stone. — ($\frac{1}{2}$). (Cat. No. $\frac{2438}{294}$) 64, 68

FIG. 5. Celt-shaped amulet of stone. — ($\frac{1}{2}$). (Cat. No. $\frac{2438}{295}$) 68

FIG. 6. Celt-shaped amulet of stone. — ($\frac{1}{2}$). (Cat. No. $\frac{2438}{296}$) 68

FIG. 7. Celt-shaped amulet of stone. — ($\frac{1}{2}$). (Cat. No. $\frac{2939}{349}$) 68, 75

FIG. 8. Celt-shaped amulet of stone. — ($\frac{1}{2}$). (Cat. No. $\frac{2939}{276}$) 68, 75

FIG. 9. Celt with geometrical designs. — ($\frac{1}{1}$). (Cat. No. $\frac{2939}{16255}$) 50, 66, 75

FIG. 10. Celt-shaped amulet of stone cut in two. — ($\frac{1}{2}$). (Cat. No. $\frac{2939}{4110}$) 64, 69

FIG. 11. Celt-shaped amulet of stone cut in two. — ($\frac{1}{2}$). (Cat. No. $\frac{2939}{4111}$) 64, 69

FIG. 12. Celt-shaped amulet of stone. — ($\frac{1}{2}$). (Cat. No. $\frac{2939}{6258}$) 64, 75

FIG. 13. Celt-shaped amulet of stone. — ($\frac{1}{2}$). (Cat. No. $\frac{2939}{2777}$) 65, 69

FIG. 14. Celt with geometrical designs. — ($\frac{1}{2}$). (Cat. No. $\frac{2939}{16254}$) 50

FIG. 15. Celt-shaped amulet of stone. — ($\frac{1}{1}$). (Nat. Mus. of Costa Rica, No. 7953) 69

FIG. 16. Celt-shaped amulet of stone. — ($\frac{1}{2}$). (Cat. No. $\frac{2939}{6660}$) 69

FIG. 17. Celt-shaped amulet of stone cut in two. — ($\frac{1}{2}$). (Cat. No. $\frac{2939}{6599}$) 64, 69

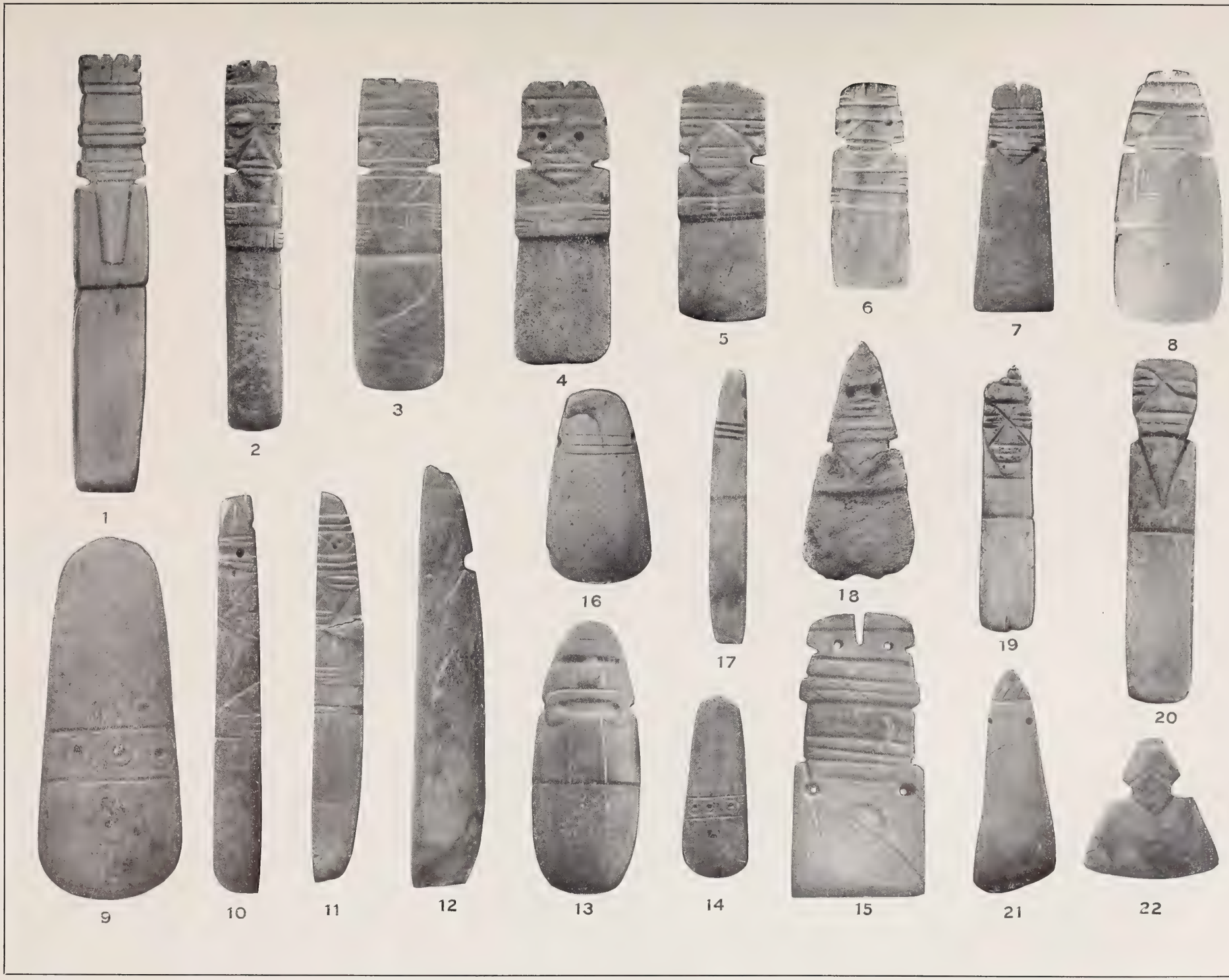
FIG. 18. Celt-shaped amulet of stone. — ($\frac{1}{2}$). (Cat. No. $\frac{2438}{3688}$) 69

FIG. 19. Celt-shaped amulet of stone. — ($\frac{1}{2}$). (Cat. No. $\frac{2939}{3988}$) 69

FIG. 20. Celt-shaped amulet of stone. — ($\frac{1}{2}$). (Cat. No. $\frac{2438}{2883}$) 69

FIG. 21. Celt-shaped amulet of stone. — ($\frac{1}{2}$). (Cat. No. $\frac{2438}{4775}$) 69

FIG. 22. Celt-shaped amulet of stone. — ($\frac{1}{2}$). (Cat. No. $\frac{2438}{4776}$) 74



AMULETS OF STONE FROM LAS GUACAS CONTAINED IN THE VELASCO COLLECTION OF THE CARNEGIE MUSEUM AND THE NATIONAL MUSEUM OF COSTA RICA.

EXPLANATION OF PLATE XXXV.

PAGE.

FIG. 1. Celt-shaped amulet of stone. — $(\frac{1}{1})$. (Cat. No. $\frac{2939}{407}$) 69

FIG. 2. Celt-shaped amulet of stone. — $(\frac{1}{1})$. (Cat. No. $\frac{2939}{400}$) 69

FIG. 3. Celt-shaped amulet of stone. — $(\frac{1}{1})$. (Cat. No. $\frac{2939}{405}$) 69

FIG. 4. Celt-shaped amulet of stone. — $(\frac{1}{1})$. (Cat. No. $\frac{2939}{404}$) 69

FIG. 5. Celt-shaped amulet of stone. — $(\frac{1}{2})$. (Nat. Mus. of Costa Rica, No. 7831) 69

FIG. 6. Celt-shaped amulet of stone. — $(\frac{1}{2})$. (Cat. No. $\frac{2939}{399}$) 69

FIG. 7. Celt-shaped amulet of stone. — $(\frac{1}{1})$. (Nat. Mus. of Costa Rica, No. 8494) ... 69, 77

FIG. 8. Celt-shaped amulet of stone. — $(\frac{1}{1})$. (Nat. Mus. of Costa Rica, No. 8489) ... 70, 77

FIG. 9. Celt-shaped amulet of stone. — $(\frac{1}{2})$. (Cat. No. $\frac{2939}{401}$) 70

FIG. 10. Celt-shaped amulet of stone. — $(\frac{1}{2})$. (Cat. No. $\frac{2939}{1173}$) 70

FIG. 11. Celt-shaped amulet of stone. — $(\frac{1}{2})$. (Cat. No. $\frac{2939}{414}$) 70

FIG. 12. Celt-shaped amulet of stone. — $(\frac{1}{2})$. (Cat. No. $\frac{2939}{284}$) 70

FIG. 13. Celt-shaped amulet of stone. — $(\frac{1}{1})$. (Cat. No. $\frac{2939}{416}$) 70

FIG. 14. Celt-shaped amulet of stone. — $(\frac{1}{2})$. (Nat. Mus. of Costa Rica, No. 7834) 70

FIG. 15. Celt-shaped amulet of stone. — $(\frac{1}{2})$. (Cat. No. $\frac{2939}{300}$) 72

FIG. 16. Celt-shaped amulet of stone. — $(\frac{1}{1})$. (Cat. No. $\frac{2939}{11}$) 70

FIG. 17. Celt-shaped amulet of stone. — $(\frac{1}{1})$. (Nat. Mus. of Costa Rica, No. 8488) 70

FIG. 18. Celt-shaped amulet of stone. — $(\frac{1}{1})$. (Cat. No. $\frac{2939}{575}$) 72

FIG. 19. Celt-shaped amulet of stone. — $(\frac{1}{1})$. (Cat. No. $\frac{2438}{450}$) 70, 72

FIG. 20. Celt-shaped amulet of stone. — $(\frac{1}{1})$. (Cat. No. $\frac{2939}{553}$) 70, 72

FIG. 21. Celt-shaped amulet of stone. — $(\frac{1}{2})$. (Cat. No. $\frac{2939}{442}$) 70, 72

FIG. 22. Celt-shaped amulet of stone. — $(\frac{1}{2})$. (Cat. No. $\frac{2939}{576}$) 72

FIG. 23. Celt-shaped amulet of stone. — $(\frac{1}{1})$. (Cat. No. $\frac{2939}{555}$) 72

FIG. 24. Celt-shaped amulet of stone. — $(\frac{1}{2})$. (Cat. No. $\frac{2939}{301}$) 70

FIG. 25. Celt-shaped amulet of stone. — $(\frac{1}{2})$. (Cat. No. $\frac{2939}{532}$) 70, 72

AMULETS OF STONE FROM LAS GUACAS CONTAINED IN THE VELASCO COLLECTIONS OF THE CARNEGIE MUSEUM AND THE NATIONAL MUSEUM OF COSTA RICA.

EXPLANATION OF PLATE XXXVI.

PAGE.

FIG. 1. Celt-shaped amulet of stone. — ($\frac{1}{2}$). (Cat. No. $\frac{2939}{440}$) 72

FIG. 2. Celt-shaped amulet of stone. — ($\frac{1}{2}$). (Cat. No. $\frac{2939}{440}$) 72

FIG. 3. Celt-shaped amulet of stone. — ($\frac{1}{2}$). (Cat. No. $\frac{2939}{441}$) 72

FIG. 4. Celt-shaped amulet of stone. — ($\frac{1}{2}$). (Nat. Mus. of Costa Rica, No. 7853) 72

FIG. 5. Celt-shaped amulet of stone. — ($\frac{1}{2}$). (Cat. No. $\frac{2939}{453}$) 72

FIG. 6. Celt-shaped amulet of stone. — ($\frac{1}{2}$). (Cat. No. $\frac{2438}{440}$) 72

FIG. 7. Celt-shaped amulet of stone. — ($\frac{1}{2}$). (Cat. No. $\frac{2438}{441}$) 72

FIG. 8. Celt-shaped amulet of stone. — ($\frac{1}{2}$). (Nat. Mus. of Costa Rica, No. 7745) 72

FIG. 9. Celt-shaped amulet of stone. — ($\frac{1}{2}$). (Cat. No. $\frac{2939}{458}$) 73

FIG. 10. Celt-shaped amulet of stone. — ($\frac{1}{2}$). (Cat. No. $\frac{2438}{404}$) 73

FIG. 11. Celt-shaped amulet of stone. — ($\frac{1}{2}$). (Nat. Mus. of Costa Rica, No. 3329) 73

FIG. 12. Celt-shaped amulet of stone. — ($\frac{1}{2}$). (Nat. Mus. of Costa Rica, No. 7826) 73

FIG. 13. Celt-shaped amulet of stone. — ($\frac{1}{2}$). (Nat. Mus. of Costa Rica, No. 10679) 73

FIG. 14. Celt-shaped amulet of stone. — ($\frac{1}{1}$). (Nat. Mus. of Costa Rica, No. 7817) 73

FIG. 15. Celt-shaped amulet of stone. — ($\frac{1}{2}$). (Cat. No. $\frac{2438}{437}$) 73

FIG. 16. Celt-shaped amulet of stone. — ($\frac{1}{2}$). (Cat. No. $\frac{2939}{448}$) 73

FIG. 17. Celt-shaped amulet of stone. — ($\frac{1}{2}$). (Cat. No. $\frac{2438}{436}$) 73

FIG. 18. Celt-shaped amulet of stone. — ($\frac{1}{2}$). (Cat. No. $\frac{2939}{446}$) 73

FIG. 19. Celt-shaped amulet of stone. — ($\frac{1}{2}$). (Nat. Mus. of Costa Rica, No. 7752) 71, 73

FIG. 20. Celt-shaped amulet of stone. — ($\frac{1}{1}$). (Nat. Mus. of Costa Rica) 73

FIG. 21. Celt-shaped amulet of stone. — ($\frac{1}{2}$). (Nat. Mus. of Costa Rica) 71, 73

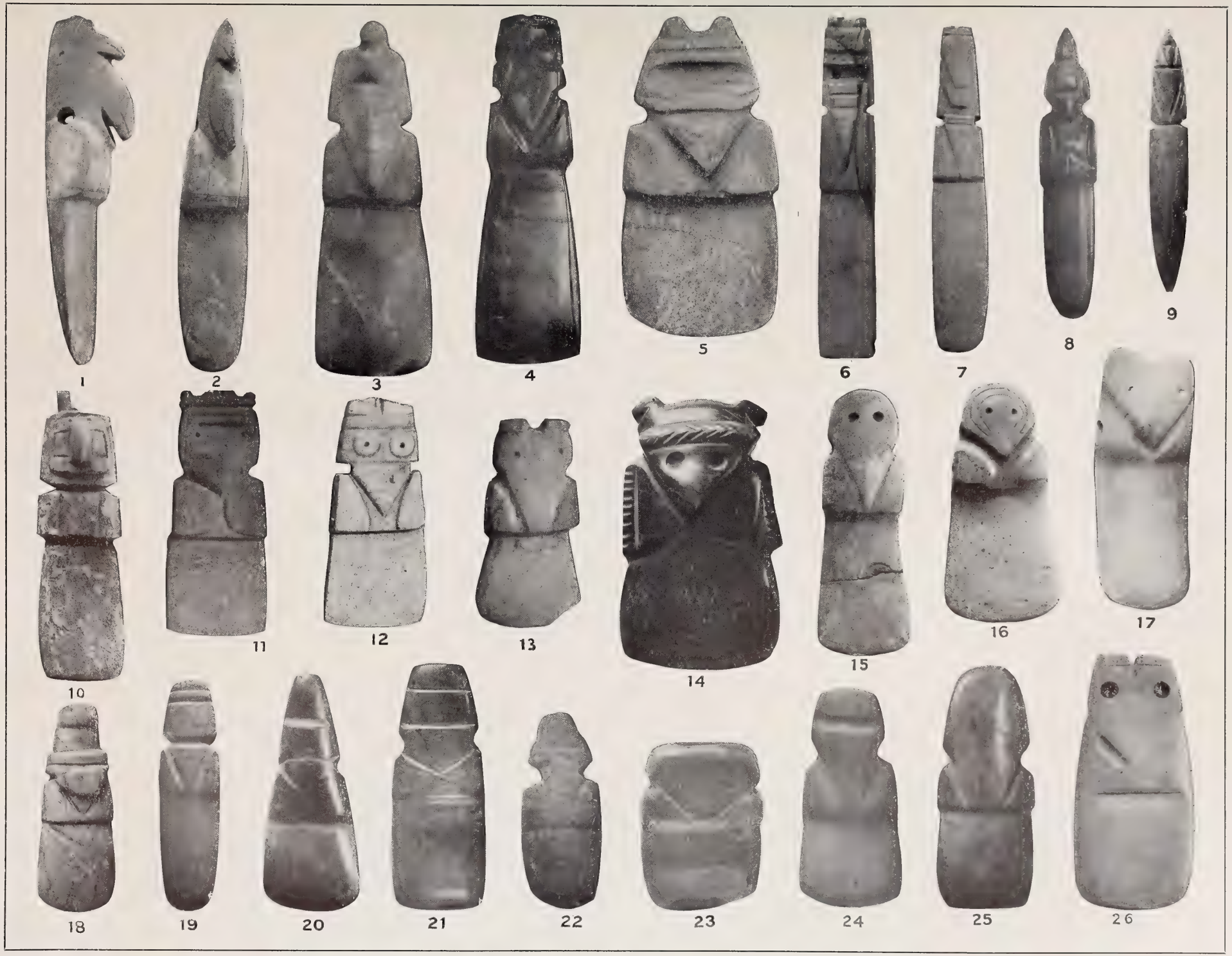
FIG. 22. Celt-shaped amulet of stone. — ($\frac{1}{1}$). (Nat. Mus. of Costa Rica) 71, 73

FIG. 23. Celt-shaped amulet of stone. — ($\frac{1}{2}$). (Nat. Mus. of Costa Rica, No. 8146) 73

FIG. 24. Celt-shaped amulet of stone. — ($\frac{1}{1}$). (Nat. Mus. of Costa Rica, No. 8170) 73

FIG. 25. Celt-shaped amulet of stone. — ($\frac{1}{1}$). (Cat. No. $\frac{2793}{125}$) 73

FIG. 26. Celt-shaped amulet of stone. — ($\frac{1}{2}$). (Cat. No. $\frac{2438}{435}$) 73



AMULETS OF STONE FROM LAS GUACAS CONTAINED IN THE VELASCO COLLECTIONS OF THE CARNEGIE MUSEUM AND THE NATIONAL MUSEUM OF COSTA RICA.

EXPLANATION OF PLATE XXXVII.

PAGE.

FIG. 1. Celt-shaped amulet of stone. — ($\frac{1}{1}$). (Cat. No. $\frac{293939}{579}$). 74

FIG. 2. Celt-shaped amulet of stone. — ($\frac{1}{1}$). (Nat. Mus. of Costa Rica). 74

FIG. 3. Celt-shaped amulet of stone. — ($\frac{1}{1}$). (Nat. Mus. of Costa Rica). 74

FIG. 4. Celt-shaped amulet of stone. — ($\frac{1}{1}$). (Cat. No. $\frac{293939}{600}$). 74

FIG. 5. Celt-shaped amulet of stone. — ($\frac{1}{2}$). (Cat. No. $\frac{293939}{484}$). 74

FIG. 6. Celt-shaped amulet of stone. — ($\frac{1}{2}$). (Cat. No. $\frac{293939}{615}$). 74

FIG. 7. Celt-shaped amulet of stone. — ($\frac{1}{1}$). (Cat. No. $\frac{293939}{609}$). 74

FIG. 8. Celt-shaped amulet of stone. — ($\frac{1}{2}$). (Cat. No. $\frac{243838}{481}$). 74

FIG. 9. Celt-shaped amulet of stone. — ($\frac{1}{2}$). (Cat. No. $\frac{293939}{627}$). 64, 74

FIG. 10. Celt-shaped amulet of stone. — ($\frac{1}{2}$). (Cat. No. $\frac{293939}{680}$). 64, 74

FIG. 11. Celt-shaped amulet of stone. — ($\frac{1}{2}$). (Cat. No. $\frac{293939}{630}$). 64, 74

FIG. 12. Celt-shaped amulet of stone. — ($\frac{1}{2}$). (Cat. No. $\frac{293939}{890}$). 74, 75

FIG. 13. Celt-shaped amulet of stone. — ($\frac{1}{2}$). (Cat. No. $\frac{293939}{896}$). 75

FIG. 14. Celt-shaped amulet of stone. — ($\frac{1}{2}$). (Cat. No. $\frac{293939}{896}$). 75

FIG. 15. Celt-shaped amulet of stone. — ($\frac{1}{2}$). (Cat. No. $\frac{293939}{763}$). 75

FIG. 16. Celt-shaped amulet of stone. — ($\frac{1}{2}$). (Cat. No. $\frac{293939}{894}$). 75

FIG. 17. Celt-shaped amulet of stone. — ($\frac{1}{2}$) (Cat. No. $\frac{293939}{941}$). 64, 75

FIG. 18. Celt-shaped amulet of stone. — ($\frac{1}{2}$). (Cat. No. $\frac{293939}{721}$). 75

FIG. 19. Celt-shaped amulet of stone. — ($\frac{1}{2}$). (Cat. No. $\frac{293939}{950}$). 75

FIG. 20. Celt-shaped amulet of stone. — ($\frac{1}{2}$). (Cat. No. $\frac{293939}{593}$). 74

FIG. 21. Celt-shaped amulet of stone. — ($\frac{1}{2}$). (Cat. No. $\frac{293939}{594}$). 74

FIG. 22. Celt-shaped amulet of stone. — ($\frac{1}{2}$). (Cat. No. $\frac{293939}{602}$). 74

FIG. 23. Celt-shaped amulet of stone. — ($\frac{1}{2}$). (Cat. No. $\frac{293939}{861}$). 75

FIG. 24. Celt-shaped amulet of stone. — ($\frac{1}{1}$). (Cat. No. $\frac{243838}{568}$). 75

FIG. 25. Celt-shaped polishing stone. — ($\frac{1}{2}$). (Cat. No. $\frac{243838}{45}$). 52

FIG. 26. Same stone from the other side. 52

FIG. 27. Celt-shaped amulet of stone. — ($\frac{1}{1}$). (Cat. No. $\frac{293939}{11644}$). 76, 77

AMULETS, ETC., OF STONE FROM LAS GUACAS CONTAINED IN THE VELASCO COLLECTIONS OF THE CARNEGIE MUSEUM AND THE NATIONAL MUSEUM OF COSTA RICA.

EXPLANATION OF PLATE XXXVIII.

PAGE.

FIG. 1. Amulet of stone. — ($\frac{1}{2}$). (Cat. No. $\frac{2}{1}\frac{9}{1}\frac{3}{5}\frac{9}{7}$) 76

FIG. 2. Amulet of stone. — ($\frac{1}{2}$). (Cat. No. $\frac{2}{1}\frac{9}{1}\frac{3}{5}\frac{9}{5}$) 76

FIG. 3. Amulet of stone. — ($\frac{1}{2}$). (Cat. No. $\frac{2}{1}\frac{9}{1}\frac{3}{5}\frac{9}{2}$) 76

FIG. 4. Amulet of stone. — ($\frac{1}{2}$). (Cat. No. $\frac{2}{1}\frac{9}{1}\frac{3}{5}\frac{9}{4}$) 76

FIG. 5. Amulet of stone. — ($\frac{1}{2}$). (Cat. No. $\frac{2}{8}\frac{4}{2}\frac{3}{8}\frac{8}{8}$) 76

FIG. 6. Amulet of stone. — ($\frac{1}{2}$). (Cat. No. $\frac{2}{1}\frac{9}{1}\frac{3}{6}\frac{9}{2}$) 76

FIG. 7. Amulet of stone. — ($\frac{1}{2}$). (Nat. Mus. of Costa Rica, No. 7858) 76

FIG. 8. Amulet of stone. — ($\frac{1}{1}$). (Nat. Mus. of Costa Rica, No. 7712) 76

FIG. 9. Amulet of stone. — ($\frac{1}{2}$). (Cat. No. $\frac{2}{1}\frac{9}{1}\frac{3}{6}\frac{9}{0}$) 76

FIG. 10. Amulet of stone. — ($\frac{1}{2}$). (Cat. No. $\frac{2}{1}\frac{9}{1}\frac{3}{6}\frac{9}{1}$) 76

FIG. 11. Amulet of stone. — ($\frac{1}{2}$). (Cat. No. $\frac{2}{1}\frac{9}{1}\frac{3}{5}\frac{9}{6}$) 76

FIG. 12. Amulet of stone. — ($\frac{1}{2}$). (Cat. No. $\frac{2}{1}\frac{9}{1}\frac{3}{6}\frac{9}{3}$) 76

FIG. 13. Amulet of stone. — ($\frac{1}{2}$). (Cat. No. $\frac{2}{1}\frac{9}{1}\frac{3}{5}\frac{9}{8}$) 76

FIG. 14. Amulet of stone. — ($\frac{1}{2}$). (Cat. No. $\frac{2}{1}\frac{9}{1}\frac{3}{5}\frac{9}{9}$) 76, 77

FIG. 15. Amulet of stone. — ($\frac{1}{2}$). (Cat. No. $\frac{2}{8}\frac{4}{3}\frac{3}{1}\frac{8}{1}$) 76, 77

FIG. 16. Amulet of stone. — ($\frac{1}{2}$). (Cat. No. $\frac{2}{1}\frac{9}{1}\frac{3}{5}\frac{9}{8}$) 76

FIG. 17. Amulet of stone. — ($\frac{1}{2}$). (Cat. No. $\frac{2}{1}\frac{9}{1}\frac{3}{6}\frac{9}{8}$) 76, 77

FIG. 18. Amulet of stone. — ($\frac{1}{2}$). (Cat. No. $\frac{2}{1}\frac{9}{1}\frac{3}{6}\frac{9}{9}$) 76, 77

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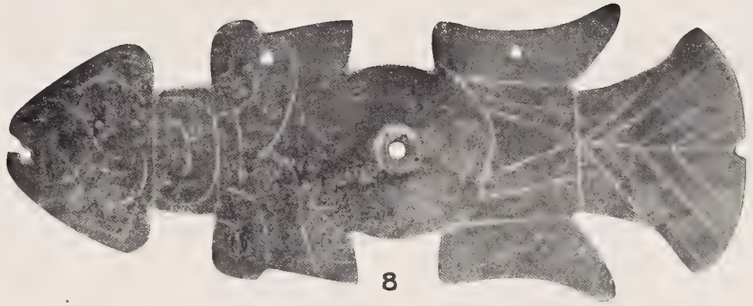
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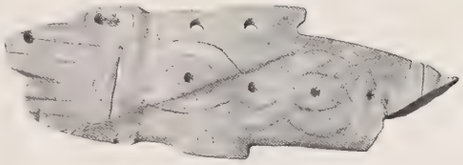
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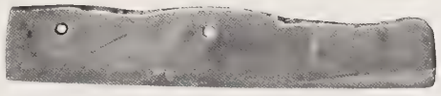
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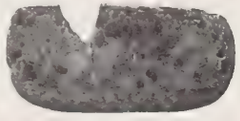
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AMULETS OF STONE FROM LAS GUACAS CONTAINED IN THE VELASCO COLLECTIONS OF THE CARNEGIE MUSEUM AND THE NATIONAL MUSEUM OF COSTA RICA.

EXPLANATION OF PLATE XXXIX.

PAGE.

FIG. 1. Amulet of stone. — $(\frac{1}{1})$. (Nat. Mus. of Costa Rica, No. 8406) 77

FIG. 2. Amulet of stone. — $(\frac{1}{1})$. (Nat. Mus. of Costa Rica, No. 8406) 77

FIG. 3. Amulet of stone. — $(\frac{1}{1})$. (Cat. No. $\frac{2438}{874}$) 77

FIG. 4. Amulet of stone. — $(\frac{1}{2})$. (Cat. No. $\frac{2438}{876}$) 77

FIG. 5. Amulet of stone. — $(\frac{1}{2})$. (Cat. No. $\frac{2939}{1262}$) 77

FIG. 6. Amulet of stone. — $(\frac{1}{1})$. (Cat. No. $\frac{2939}{1265}$) 77

FIG. 7. Amulet of stone. — $(\frac{1}{1})$. (Cat. No. $\frac{2939}{1266}$) 77

FIG. 8. Amulet of stone. — $(\frac{1}{1})$. (Cat. No. $\frac{2939}{1276}$) 78

FIG. 9. Amulet of stone. — $(\frac{1}{1})$. (Cat. No. $\frac{2939}{1275}$) 79

FIG. 10. Amulet of stone. — $(\frac{1}{1})$. (Cat. No. $\frac{2438}{872}$) 79

FIG. 11. Amulet of stone. — $(\frac{1}{1})$. (Cat. No. $\frac{2939}{1274}$) 79

FIGS. 12, 13. Amulet of stone. — $(\frac{1}{1})$. (Cat. No. $\frac{2939}{1270}$) 78

FIG. 14. Amulet of stone. — $(\frac{1}{1})$. (Cat. No. $\frac{2939}{1272}$) 80

FIG. 15. Amulet of stone. — $(\frac{1}{1})$. (Cat. No. $\frac{2438}{876}$) 78

FIG. 16. Amulet of stone. — $(\frac{1}{1})$. (Cat. No. $\frac{2939}{1351}$) 83

FIG. 17. Amulet of stone. — $(\frac{1}{1})$. (Cat. No. $\frac{2939}{1277}$) 80, 84

FIG. 18. Ear tube. — $(\frac{1}{1})$. (Cat. No. $\frac{2939}{1319}$) 84

FIG. 19. Human head. — $(\frac{1}{1})$. (Nat. Mus. of Costa Rica) 78

FIG. 20. Ear tube. — $(\frac{1}{1})$. (Cat. No. $\frac{2939}{1320}$) 84

FIG. 21. Bell of quartz. — $(\frac{1}{1})$. (Cat. No. $\frac{2939}{1330}$) 84

FIG. 22. Head of deer. — $(\frac{1}{1})$. (Cat. No. $\frac{2939}{1273}$) 80

FIG. 23. Bell of stone. — $(\frac{1}{1})$. (Cat. No. $\frac{2939}{1351}$) 84

FIG. 24. Bell of stone. — $(\frac{1}{1})$. (Cat. No. $\frac{2793}{129}$) 84

FIG. 25. Cup of stone. — $(\frac{1}{2})$. (Cat. No. $\frac{2939}{1314}$) 84

FIG. 26. Cylinder of stone. — $(\frac{1}{1})$. (Cat. No. $\frac{2939}{1328}$) 84

FIG. 27. Amulet of obsidian. — $(\frac{1}{2})$. (Cat. No. $\frac{2939}{1291}$) 84

FIG. 28. Cylinder of bowenite. — $(\frac{1}{1})$. (Cat. No. $\frac{2939}{1325}$) 84

FIG. 29. Cup of bowenite. — $(\frac{1}{1})$. (Cat. No. $\frac{2939}{1318}$) 84

FIG. 30. Lip-plug? — $(\frac{1}{1})$. (Cat. No. $\frac{2939}{1307}$) 84

FIG. 31. Object of quartz. — $(\frac{1}{1})$. (Cat. No. $\frac{2939}{1298}$) 84

FIG. 32. Object of green stone. — $(\frac{1}{1})$. (Nat. Mus. of Costa Rica) 85

FIG. 33. Object of quartz. — $(\frac{1}{1})$. (Cat. No. $\frac{2939}{1297}$) 85

FIG. 34. Cylinder of bowenite. — $(\frac{1}{1})$. (Cat. No. $\frac{2939}{1321}$) 85

AMULETS AND VARIOUS OTHER OBJECTS OF STONE FROM LAS GUACAS CONTAINED IN THE VELASCO COLLECTIONS OF THE CARNEGIE MUSEUM AND THE NATIONAL MUSEUM OF COSTA RICA.

EXPLANATION OF PLATE XL.

PAGE.

FIG. 1. Amulet of stone. — ($\frac{1}{1}$). (Cat. No. $\frac{2\,9\,3\,9}{1\,2\,2\,0}$) 78

FIG. 2. Amulet of stone. — ($\frac{1}{1}$). (Cat. No. $\frac{2\,9\,3\,9}{1\,2\,0\,9}$) 78

FIG. 3. Amulet of stone. — ($\frac{1}{1}$). (Nat. Mus. of Costa Rica, No. 3388) 78

FIG. 4. Amulet of stone. — ($\frac{1}{1}$). (Nat. Mus. of Costa Rica, No. 10868) 78

FIG. 5. Amulet of stone. — ($\frac{1}{1}$). (Cat. No. $\frac{2\,9\,3\,9}{1\,2\,1\,2}$) 78

FIG. 6. Amulet of stone. — ($\frac{1}{1}$). (Cat. No. $\frac{2\,9\,3\,9}{1\,2\,1\,0}$) 78

FIG. 7. Amulet of stone. — ($\frac{1}{1}$). (Nat. Mus. of Costa Rica, No. 8404) 78

FIG. 8. Amulet of stone. — ($\frac{1}{1}$). (Cat. No. $\frac{2\,5\,3\,8}{8\,4\,4}$) 78

FIG. 9. Amulet of stone. — ($\frac{1}{1}$). (Cat. No. $\frac{2\,9\,3\,9}{1\,2\,1\,3}$) 78

FIG. 10. Amulet of stone. — ($\frac{1}{1}$). (Nat. Mus. of Costa Rica, No. 10889) 78, 79

FIG. 11. Amulet of stone. — ($\frac{1}{2}$). (Cat. No. $\frac{2\,9\,3\,9}{1\,2\,9\,3}$) 78, 79

FIG. 12. Amulet of stone. — ($\frac{1}{2}$). (Nat. Mus. of Costa Rica, No. 10781) 78, 79

FIG. 13. Amulet of stone. — ($\frac{1}{1}$). (Cat. No. $\frac{2\,9\,3\,9}{1\,2\,2\,1}$) 78, 79

FIG. 14. Amulet of stone. — ($\frac{1}{1}$). (Cat. No. $\frac{2\,7\,9\,3}{4\,1}$) 78, 79

FIG. 15. Amulet of stone. — ($\frac{1}{1}$). (Cat. No. $\frac{2\,9\,3\,9}{1\,2\,1\,4}$) 78, 79

FIG. 16. Amulet of stone. — ($\frac{1}{1}$). (Cat. No. $\frac{2\,7\,9\,3}{4\,1}$) 78, 79

FIG. 17. Amulet of stone. — ($\frac{1}{1}$). (Cat. No. $\frac{2\,9\,3\,9}{1\,2\,3\,1}$) 80

FIG. 18. Amulet of stone. — ($\frac{1}{1}$). (Cat. No. $\frac{2\,9\,3\,9}{1\,2\,2\,9}$) 80

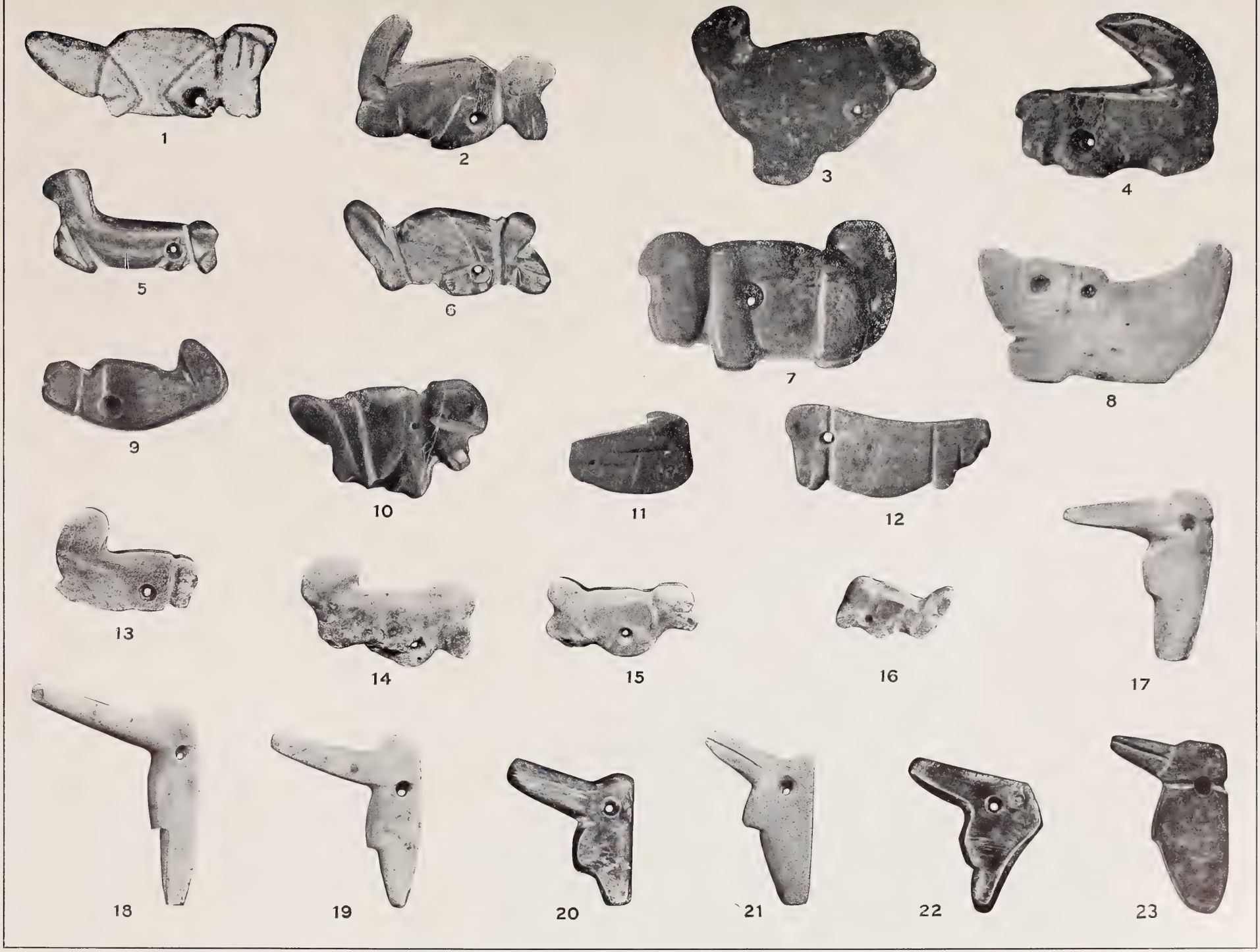
FIG. 19. Amulet of stone. — ($\frac{1}{1}$). (Cat. No. $\frac{2\,9\,3\,9}{1\,2\,3\,0}$) 80

FIG. 20. Amulet of stone. — ($\frac{1}{1}$). (Cat. No. $\frac{2\,9\,3\,9}{1\,2\,4\,0}$) 80

FIG. 21. Amulet of stone. — ($\frac{1}{1}$). (Cat. No. $\frac{2\,9\,3\,9}{1\,2\,3\,4}$) 80

FIG. 22. Amulet of stone. — ($\frac{1}{1}$). (Cat. No. $\frac{2\,9\,3\,9}{1\,2\,4\,6}$) 80

FIG. 23. Amulet of stone. — ($\frac{1}{1}$). (Cat. No. $\frac{2\,4\,3\,8}{8\,5\,8}$) 80



AMULETS OF STONE FROM LAS GUACAS CONTAINED IN THE VELASCO COLLECTIONS OF THE CARNEGIE MUSEUM AND THE NATIONAL MUSEUM OF COSTA RICA.

EXPLANATION OF PLATE XLI.

PAGE

FIG. 1. Amulet of stone. — ($\frac{1}{2}$). (Cat. No. $\frac{2}{1}\frac{9}{1}\frac{3}{8}\frac{9}{3}$) 78, 79

FIG. 2. Amulet of stone. — ($\frac{1}{1}$). (Cat. No. $\frac{2}{8}\frac{4}{3}\frac{3}{7}\frac{8}{7}$) 78, 79

FIG. 3. Amulet of stone. — ($\frac{1}{1}$). (Cat. No. $\frac{2}{8}\frac{4}{3}\frac{3}{6}\frac{8}{6}$) 78, 79

FIG. 4. Amulet of stone. — ($\frac{1}{2}$). (Cat. No. $\frac{2}{1}\frac{9}{1}\frac{3}{8}\frac{9}{4}$) 78, 79

FIG. 5. Amulet of stone. — ($\frac{1}{2}$). (Nat. Mus. of Costa Rica, No. 8130) 78, 79

FIG. 6. Amulet of stone. — ($\frac{1}{2}$). (Nat. Mus. of Costa Rica, No. 8490) 78, 79

FIG. 7. Amulet of stone. — ($\frac{1}{2}$). (Nat. Mus. of Costa Rica, No. 8133) 78, 79

FIG. 8. Amulet of stone. — ($\frac{1}{1}$). (Cat. No. $\frac{2}{1}\frac{9}{1}\frac{3}{8}\frac{9}{5}$) 78, 79

FIG. 9. Amulet of stone. — ($\frac{1}{2}$). (Nat. Mus. of Costa Rica, No. 8342) 78, 79

FIG. 10. Amulet of stone. — ($\frac{1}{1}$). (Cat. No. $\frac{2}{1}\frac{9}{2}\frac{3}{0}\frac{9}{0}$) 80

FIG. 11. Amulet of stone. — ($\frac{1}{1}$). (Cat. No. $\frac{2}{1}\frac{9}{1}\frac{3}{8}\frac{9}{7}$) 80

FIG. 12. Amulet of stone. — ($\frac{1}{2}$). (Nat. Mus. of Costa Rica, No. 8132) 80

FIG. 13. Amulet of stone. — ($\frac{1}{2}$). (Cat. No. $\frac{2}{1}\frac{9}{1}\frac{3}{8}\frac{9}{9}$) 80

FIG. 14. Amulet of stone. — ($\frac{1}{1}$). (Nat. Mus. of Costa Rica, No. 3356) 80

FIG. 15. Amulet of stone. — ($\frac{1}{1}$). (Cat. No. $\frac{2}{1}\frac{9}{2}\frac{3}{9}\frac{9}{2}$) 79

FIG. 16. Amulet of stone. — ($\frac{1}{1}$). (Cat. No. $\frac{2}{8}\frac{4}{4}\frac{3}{3}\frac{8}{}$) 80, 81

FIG. 17. Amulet of stone. — ($\frac{1}{1}$). (Cat. No. $\frac{2}{8}\frac{4}{4}\frac{3}{2}\frac{8}{}$) 80, 81

FIG. 18. Amulet of stone. — ($\frac{1}{2}$). (Cat. No. $\frac{2}{1}\frac{9}{1}\frac{3}{9}\frac{9}{3}$) 80, 81

FIG. 19. Amulet of stone. — ($\frac{1}{1}$). (Cat. No. $\frac{2}{1}\frac{9}{1}\frac{3}{8}\frac{9}{6}$) 80, 81

FIG. 20. Amulet of stone. — ($\frac{1}{1}$). (Cat. No. $\frac{2}{1}\frac{9}{1}\frac{3}{8}\frac{9}{8}$) 80, 81

FIG. 21. Amulet of stone. — ($\frac{1}{1}$). (Cat. No. $\frac{2}{1}\frac{9}{1}\frac{3}{4}\frac{9}{5}$) 80, 81

FIG. 22. Amulet of stone. — ($\frac{1}{2}$). (Cat. No. $\frac{2}{1}\frac{9}{1}\frac{3}{9}\frac{9}{4}$) 80, 81

FIG. 23. Amulet of stone. — ($\frac{1}{1}$). (Cat. No. $\frac{2}{8}\frac{4}{4}\frac{3}{1}\frac{8}{}$) 80, 81

AMULETS OF STONE FROM LAS GUACAS CONTAINED IN THE VELASCO COLLECTIONS OF THE CARNEGIE MUSEUM AND THE NATIONAL MUSEUM OF COSTA RICA.

EXPLANATION OF PLATE XLII.

PAGE.

FIG. 1. Lip ornament (?) of stone. — $(\frac{1}{1})$. (Cat. No. $\frac{2438}{9229}$) 83

FIG. 2. Same object seen from above 83

FIG. 3. Button of stone. — $(\frac{1}{1})$. (Cat. No. $\frac{2438}{933}$) 83

FIG. 4. Same object from the back 83

FIG. 5. Button of stone. — $(\frac{1}{1})$. (Cat. No. $\frac{2438}{932}$) 83

FIG. 6. Same object seen from below 83

FIG. 7. Button of stone. — $(\frac{1}{1})$. (Cat. No. $\frac{2939}{1308}$) 83

FIG. 8. Same object seen from below 83

FIG. 9. Button of stone. — $(\frac{1}{1})$. (Cat. No. $\frac{2438}{931}$) 83

FIG. 10. Same object seen from below 83

FIG. 11. Button of stone. — $(\frac{1}{1})$. (Cat. No. $\frac{2939}{1302}$) 83

FIG. 12. Same object seen from below 83

FIG. 13. Lip ornament (?). — $(\frac{1}{1})$. (Cat. No. $\frac{2438}{930}$) 83

FIG. 14. Plate of stone. — $(\frac{1}{1})$. (Cat. No. $\frac{2939}{1178}$) 83

FIG. 15. Bead of stone. — $(\frac{1}{1})$. (Cat. No. $\frac{2438}{935}$) 82

FIG. 16. Bead of stone. — $(\frac{1}{1})$. (Cat. No. $\frac{2939}{1606}$) 82

FIG. 17. Disk of stone. — $(\frac{1}{1})$. (Cat. No. $\frac{2939}{1299}$) 84

FIG. 18. Disk of stone. — $(\frac{1}{1})$. (Cat. No. $\frac{2438}{937}$) 84

FIG. 19. Button of stone. — $(\frac{1}{1})$. (Cat. No. $\frac{2939}{1303}$) 84

FIG. 20. Same object seen from below 84

FIG. 21. Tube of stone. — $(\frac{1}{1})$. (Cat. No. $\frac{2939}{1404}$) 82

FIG. 22. Tube of stone. — $(\frac{1}{1})$. (Cat. No. $\frac{2939}{1421}$) 82, 84

FIG. 23. Tube of stone. — $(\frac{1}{1})$. (Cat. No. $\frac{2932}{1401}$) 82

FIG. 24. Tube of stone. — $(\frac{1}{1})$. (Cat. No. $\frac{2939}{1398}$) 82

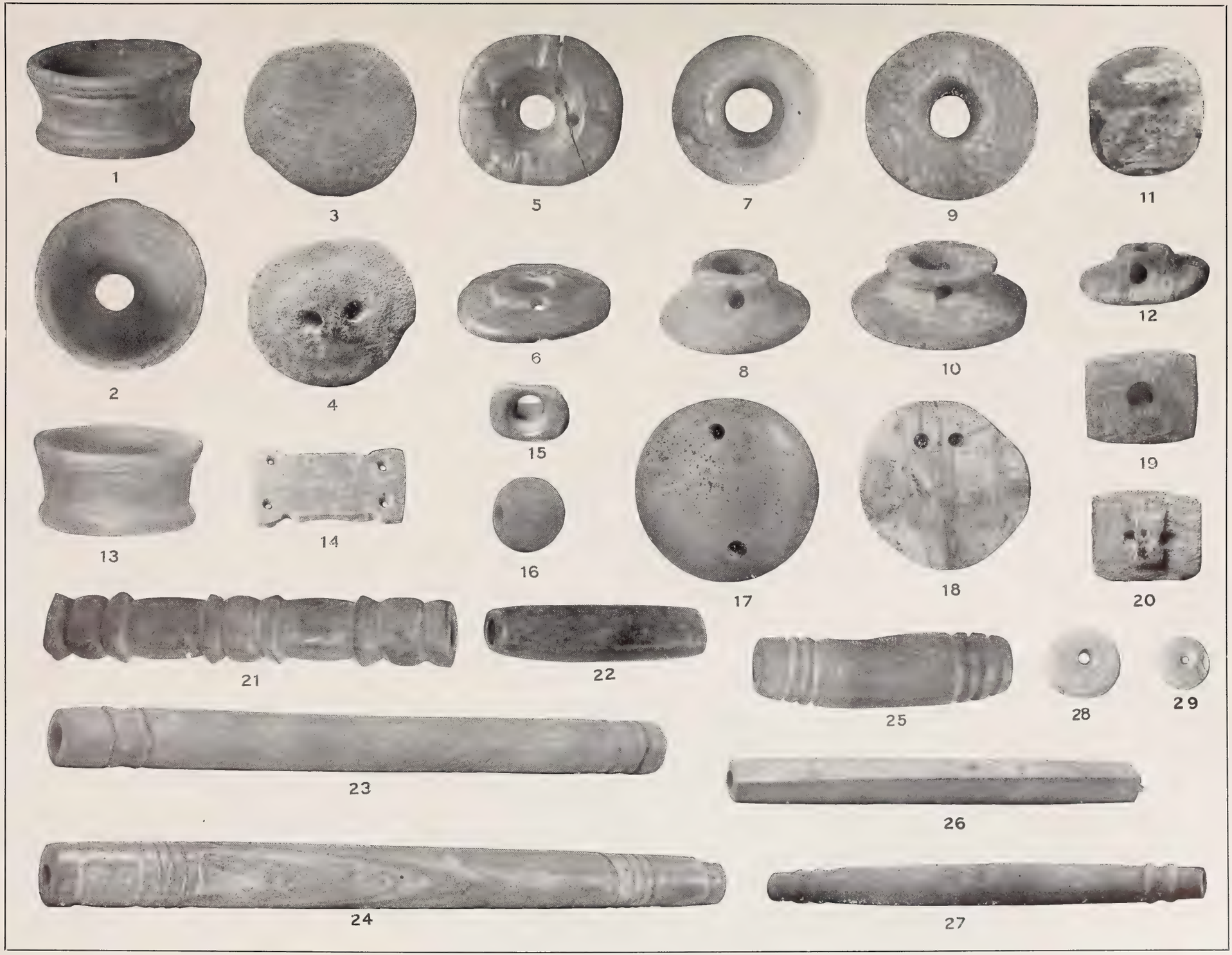
FIG. 25. Tube of stone. — $(\frac{1}{2})$. (Cat. No. $\frac{2939}{1400}$) 82

FIG. 26. Tube of stone. — $(\frac{1}{2})$. (Cat. No. $\frac{2939}{1420}$) 82

FIG. 27. Tube of stone. — $(\frac{1}{2})$. (Cat. No. $\frac{2939}{1402}$) 82

FIG. 28. Bead of stone. — $(\frac{1}{1})$. (Cat. No. $\frac{2793}{100}$) 82

FIG. 29. Bead of stone. — $(\frac{1}{1})$. (Cat. No. $\frac{2939}{1068}$) 83



TUBES, BUTTONS, AND OTHER SMALL OBJECTS OF STONE FROM LAS GUACAS CONTAINED IN THE VELASCO COLLECTIONS OF THE CARNEGIE MUSEUM AND THE NATIONAL MUSEUM OF COSTA RICA.

EXPLANATION OF PLATE XLIII.

(All figures full size.)

PAGE.

FIG. 1. Amulet of bluish green jadeite. (Cat. No. $\frac{2}{4}\frac{9}{0}\frac{3}{6}\frac{9}{}$) 87

FIG. 2. Amulet of yellowish green polished stone. (Cat. No. $\frac{2}{2}\frac{9}{6}\frac{3}{6}\frac{9}{}$) 87

FIG. 3. Amulet of jadeite. (Cat. No. $\frac{2}{2}\frac{9}{6}\frac{3}{2}\frac{9}{}$) 87

FIG. 4. Amulet of bluish green jadeite. (Cat. No. $\frac{2}{4}\frac{9}{1}\frac{3}{0}\frac{9}{}$) 87

FIG. 5. Amulet of jadeite. (Cat. No. $\frac{2}{4}\frac{9}{1}\frac{3}{2}\frac{9}{}$) 87

FIG. 6. Amulet of jadeite. (Cat. No. $\frac{2}{5}\frac{9}{4}\frac{3}{9}\frac{9}{}$) 87

FIG. 7. Amulet of jadeite. (Cat. No. $\frac{2}{9}\frac{9}{7}\frac{3}{1}\frac{9}{}$) 87

FIG. 8. Amulet of jadeite. (Cat. No. $\frac{2}{9}\frac{9}{2}\frac{3}{4}\frac{9}{}$) 87

FIG. 9. Amulet of jadeite. (Cat. No. $\frac{2}{9}\frac{9}{2}\frac{3}{3}\frac{9}{}$) 87

FIG. 10. Amulet of jade. (Cat. No. $\frac{2}{5}\frac{9}{3}\frac{3}{9}\frac{9}{}$) 87

OBJECTS OF JADE FROM COSTA RICA

EXPLANATION OF PLATE XLIV.

(All figures full size.)

PAGE.

FIG. 1. Amulet of jadeite. (Cat. No. $\frac{2}{5}\frac{9}{2}\frac{3}{9}\frac{9}{9}$) 87

FIG. 2. Amulet of jadeite. (Cat. No. $\frac{2}{5}\frac{9}{8}\frac{3}{0}\frac{9}{0}$) 88

FIG. 3. Amulet of jadeite. (Cat. No. $\frac{2}{3}\frac{9}{0}\frac{3}{1}\frac{9}{1}$) 88

FIG. 4. Amulet of jadeite. (Cat. No. $\frac{2}{5}\frac{9}{3}\frac{3}{0}\frac{9}{0}$) 88

FIG. 5. Amulet of highly polished stone. (Cat. No. $\frac{2}{5}\frac{9}{7}\frac{3}{9}\frac{9}{9}$) 88

FIG. 6. Amulet of jadeite. (Cat. No. $\frac{2}{1}\frac{9}{1}\frac{3}{8}\frac{9}{1}$) 78, 88

FIG. 7. Amulet of polished stone. (Cat. No. $\frac{2}{1}\frac{9}{1}\frac{3}{8}\frac{9}{2}$) 78, 88

FIG. 8. Amulet of bowenite. (Cat. No. $\frac{2}{5}\frac{9}{2}\frac{3}{0}\frac{9}{0}$) 88

FIG. 9. Amulet of jadeite. (Cat. No. $\frac{2}{5}\frac{9}{2}\frac{3}{3}\frac{9}{3}$) 88

FIG. 10. Amulet of bowenite. (Cat. No. $\frac{2}{5}\frac{9}{4}\frac{3}{8}\frac{9}{8}$) 88

FIG. 11. Amulet of jadeite (?). (Cat. No. $\frac{2}{5}\frac{9}{1}\frac{3}{9}\frac{9}{9}$) 88

OBJECTS OF JADE FROM COSTA RICA

EXPLANATION OF PLATE XLV.

(All figures full size.)

PAGE.

FIG. 1. Amulet of jadeite. (Cat. No. $\frac{2}{12}\frac{93}{51}$) 88

FIG. 2. Amulet of jade. (Cat. No. $\frac{2}{10}\frac{93}{03}$) 88

FIG. 3. Amulet of jadeite. (Cat. No. $\frac{2}{92}\frac{93}{5}$) 88

FIG. 4. Amulet of saussurite. (Cat. No. $\frac{2}{12}\frac{93}{16}$) 88

FIG. 5. Amulet of saussurite. (Cat. No. $\frac{2}{12}\frac{93}{03}$) 89

FIG. 6. Amulet of jade. (Cat. No. $\frac{2}{6}\frac{93}{3}$) 89

FIG. 7. Amulet of jadeite. (Cat. No. $\frac{2}{8}\frac{93}{92}$) 89

FIG. 8. Amulet of jade. (Cat. No. $\frac{2}{12}\frac{93}{80}$) 89

FIG. 9. Amulet of jadeite. (Cat. No. $\frac{2}{9}\frac{93}{65}$) 89

FIG. 10. Amulet of jade. (Cat. No. $\frac{2}{16}\frac{93}{28}$) 89

FIG. 11. Amulet of jadeite. (Cat. No. $\frac{2}{92}\frac{93}{6}$) 89

FIG. 12. Amulet of jadeite. (Cat. No. $\frac{2}{5}\frac{93}{56}$) 89

FIG. 13. Pendant of jadeite. (Cat. No. $\frac{2}{10}\frac{93}{08}$) 89

FIG. 14. Amulet of jadeite. (Cat. No. $\frac{2}{9}\frac{93}{70}$) 89

FIG. 15. Amulet of saussurite. (Cat. No. $\frac{2}{12}\frac{93}{94}$) 89

FIG. 16. Amulet of stone. (Cat. No. $\frac{2}{6}\frac{93}{49}$) 89

FIG. 17. Amulet of stone. (Cat. No. $\frac{2}{9}\frac{93}{69}$) 89

FIG. 18. Bead of saussurite. (Cat. No. $\frac{2}{16}\frac{93}{18}$) 89

FIG. 19. Bead of saussurite. (Cat. No. $\frac{2}{16}\frac{93}{20}$) 89

FIG. 20. Bead of saussurite. (Cat. No. $\frac{2}{16}\frac{93}{19}$) 89

FIG. 21. Amulet of jadeite. (Cat. No. $\frac{2}{9}\frac{93}{68}$) 90

FIG. 22. Amulet of jadeite. (Cat. No. $\frac{2}{9}\frac{93}{99}$) 90

FIG. 23. Pendant of jadeite. (Cat. No. $\frac{2}{2}\frac{93}{55}$) 90

FIG. 24. Amulet of saussurite. (Cat. No. $\frac{2}{12}\frac{93}{08}$) 90

FIG. 25. Tube of jadeite. (Cat. No. $\frac{2}{14}\frac{93}{04}$) 90

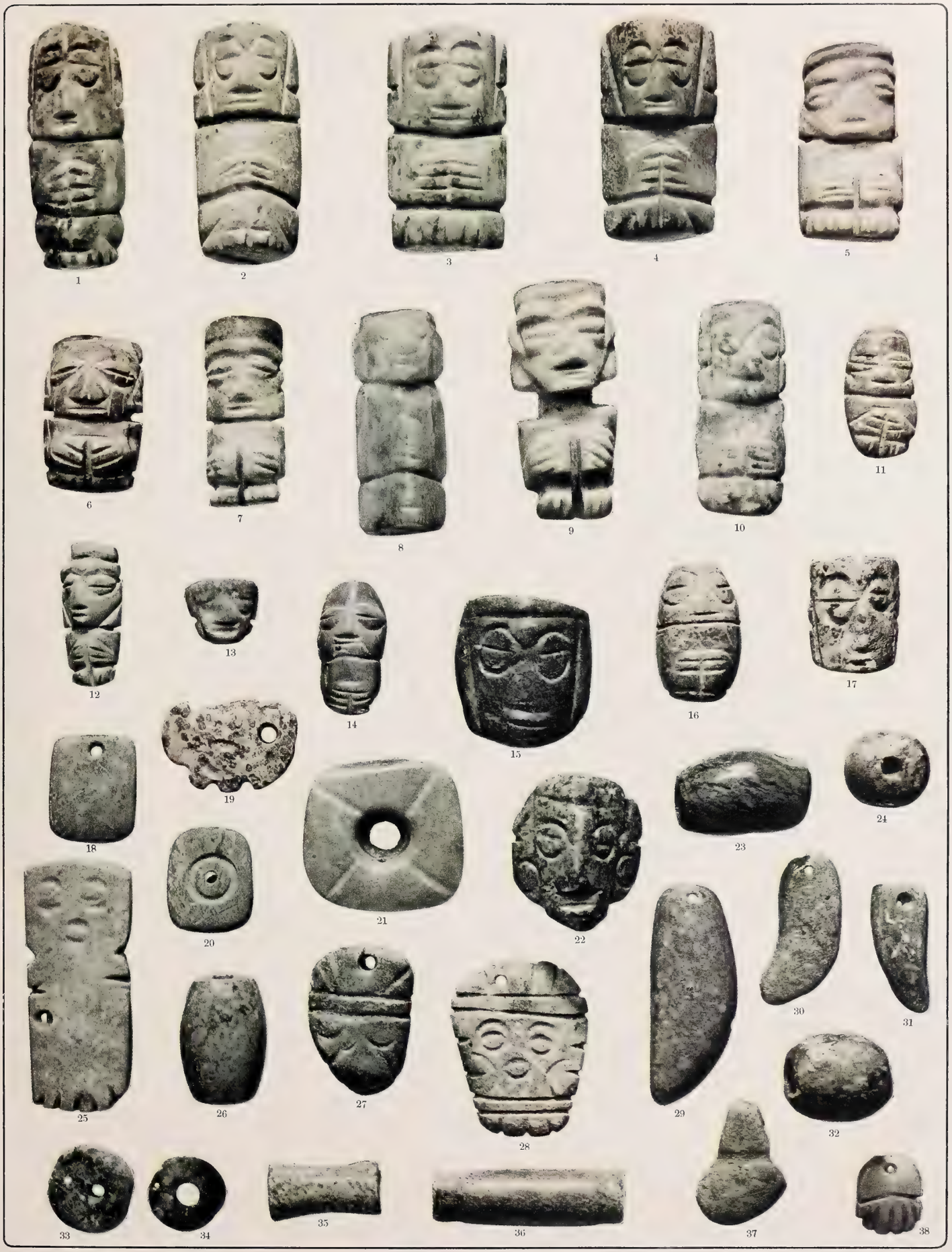
FIG. 26. Amulet of saussurite. (Cat. No. $\frac{2}{12}\frac{93}{89}$) 90

FIG. 27. Pendant of jadeite. (Cat. No. $\frac{2}{10}\frac{93}{14}$) 90

OBJECTS OF JADE FROM COSTA RICA

EXPLANATION OF PLATE XLVI.

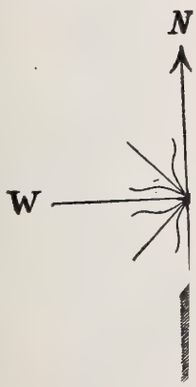
Amulets, beads and an ear-ornament of jade from the state of Oaxaca. All figures are full size. For description see pp. 90–92.



OBJECTS OF JADE FROM MEXICO

EXPLANATION OF PLATE XLVII.

Map of excavations made by C. V. Hartman in the burial ground at Las Guacas.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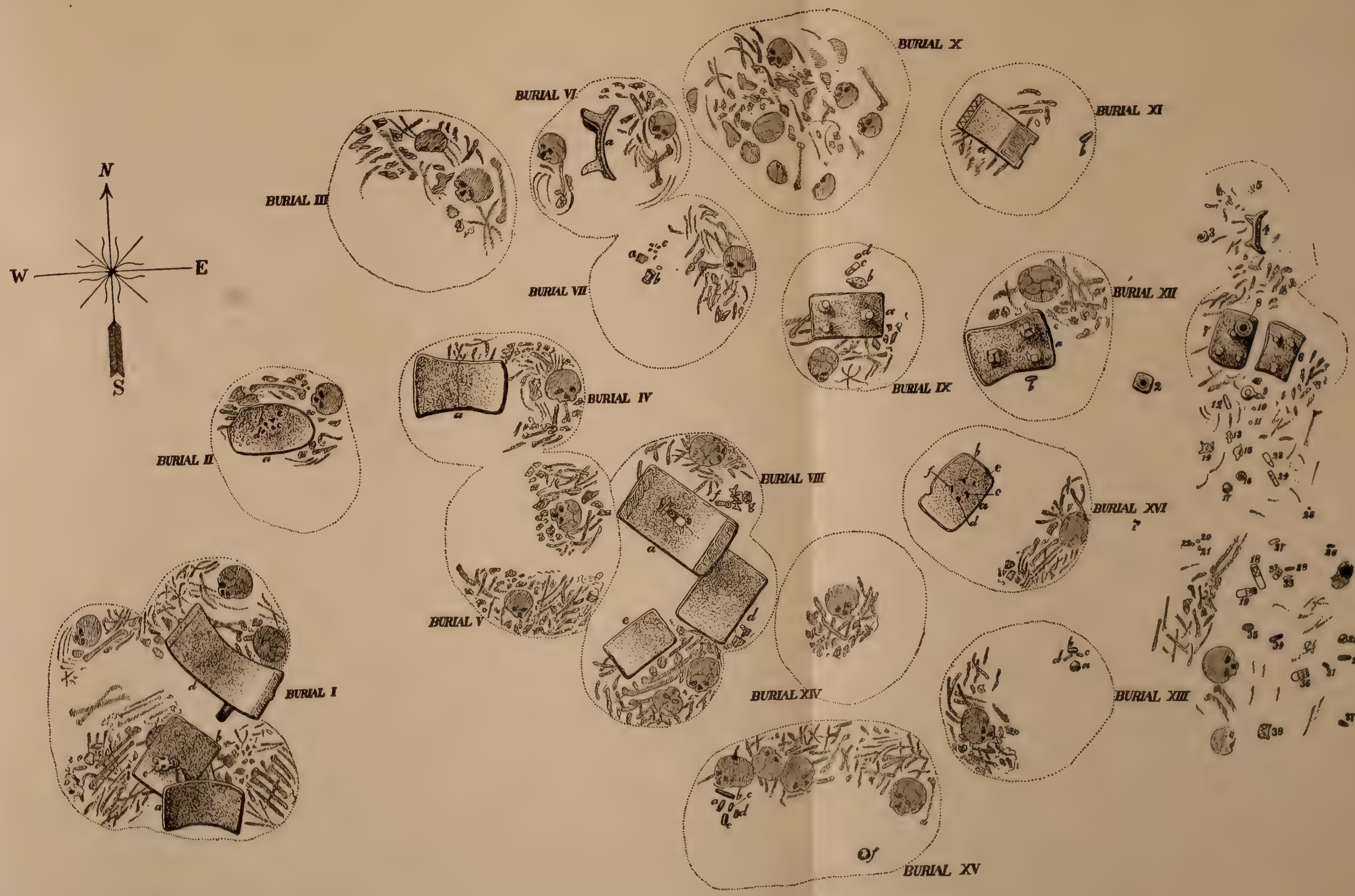

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MEMOIRS

OF THE

CARNEGIE MUSEUM.

VOL. III. NO. 2.

THE OSTEOLOGY OF THE CHALICOTHEROIDEA WITH SPECIAL REFERENCE TO A MOUNTED SKELETON OF MOROPUS ELATUS MARSH, NOW INSTALLED IN THE CARNEGIE MUSEUM.

By W. J. Holland and O. A. Peterson.

(Plates XLVIII–LXXVII.)

Introductory.

In the spring of the year 1904 a field party from the Carnegie Museum under the control of Mr. O. A. Peterson was engaged in collecting in the Tertiary beds on Monroe and Van Tassel Creeks and the Upper Niobrara River, locally known as "The Running Water," in western Nebraska. At the end of July Mr. Peterson, who several times had been courteously invited by Mr. James H. Cook, the proprietor of the Agate Spring Stock Farm, to visit him, accepted Mr. Cook's hospitality. The ranch of Mr. Cook is located on the Niobrara River, in Sioux County, about twenty-five miles southeast of Harrison, the county-seat. A few days after the arrival of Mr. Peterson he was conducted by Mr. Harold Cook, the oldest son of his host, to the locality just beyond the eastern limits of Mr. Cook's property, designated as "Quarry A" in the map (Fig. 1) accompanying this memoir. Here young Mr. Cook had noted that numerous fragments of fossil bones were lying upon the surface. Mr. Peterson immediately took steps to begin the work of systematic excavation at this point. A few days afterward,

while examining the two small buttes, which lie about three hundred yards south of Quarry A, Mr. Peterson discovered that in both of them at about the same level were extensive outcrops of a stratum containing fossil bones, fragments of which were very abundant in the talus. Mr. Peterson called the attention of Mr. James H. Cook to these spots and Mr. Cook then stated that he had observed these fragments some years before, but had mistaken them at the time for the remains of "Indian horses." Mr. Peterson, who was not well, was only able to work for about a fortnight, and left for his home in Pittsburgh on the 10th of August.

Mr. Cook was informed by Mr. Peterson prior to his departure that a party from the Carnegie Museum would return in the following spring to make systematic excavations. Mr. Cook, impelled by curiosity, undertook after the withdrawal of Mr. Peterson to make some excavations at one of the spots on the western side of the larger butte, which had been pointed out to him as rich in remains, and was rewarded by finding a number of bones. He reported his discovery by letter and was at once earnestly entreated both by Mr. Peterson and the writer to desist from further excavations until an experienced collector could assume the supervision of the work. This Mr. Cook cheerfully agreed to do. In the spring of the year 1905 Mr. Peterson, accompanied by Mr. T. F. Olcott and Dr. Albert J. Hermann, returned to the locality and during the open season of that year carried on the work of exploration and excavation with remarkable success, being joined in the latter part of the season by Mr. W. H. Utterback. Among other results of the labors of Mr. Peterson and his assistants in 1905 was the discovery of the lower jaw and the cervicals of a large specimen of *Moropus*.

In the early summer of this same year Professor Erwin H. Barbour, who in the meantime had learned of the discoveries which had been made, repaired to the spot and commenced excavating near the place where Mr. Peterson and his assistants were at work. His excavations were made in the smaller of the two buttes, which he has since named "University Hill." He labored for only a brief time, but he, too, was rewarded by finding some excellent material, among it being fragments of the same genera and species which were found by Mr. Peterson. His principal discovery was that of a fragment of the lower part of the cranium of *Moropus elatus* preserving the upper premolar-molar series of teeth on both sides and the bones of the palatal and basi-occipital region in place and not distorted by crushing. Unfortunately the entire upper and anterior portions of this skull were wanting.

In the spring of the year 1906 Mr. W. H. Utterback, who, as has been stated, had assisted Mr. Peterson in the latter part of the season of 1905, was sent to the

locality with special instructions to continue the work of uncovering the fossil-bearing stratum at the point where the investigations made by Mr. Peterson and himself in the preceding year had led to the recovery of the jaws and cervicals of the large specimen of *Moropus*. The search was rewarded by the recovery of the greater part of the skeleton. These remains were found at the spot designated in the map as "Quarry No. 1" on the western face of what Professor Barbour in

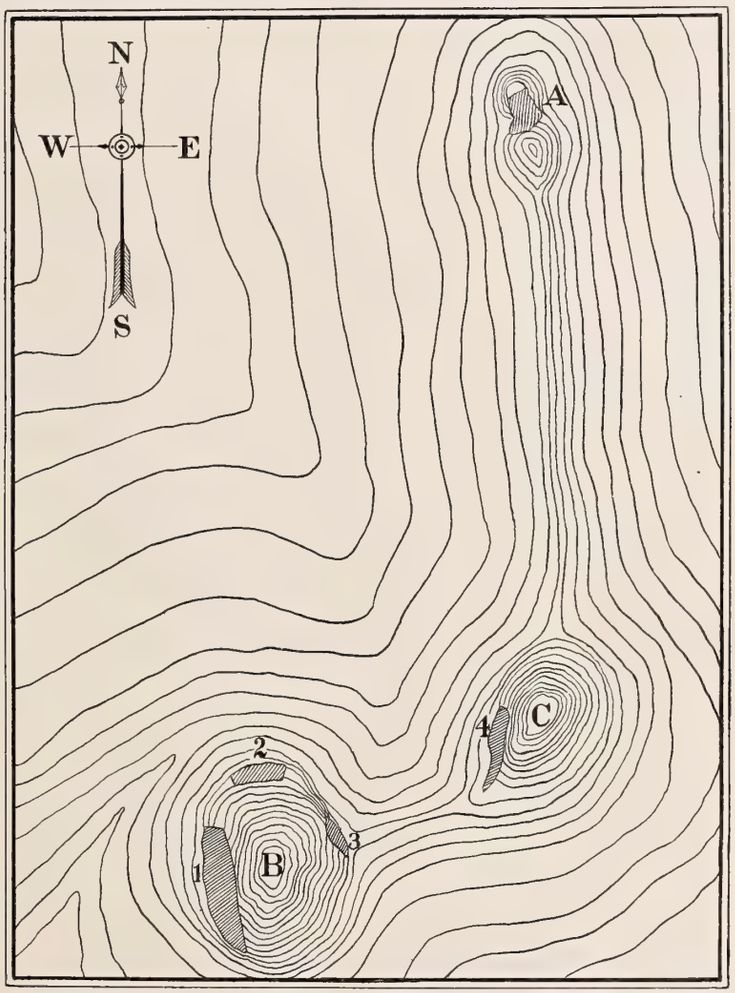


FIG. 1. Rough outline topographical map of the Agate Spring Fossil Quarries drawn by W. J. Holland. A, quarry opened by Mr. O. A. Peterson in 1904. B, "Carnegie Hill." 1 and 2, quarries opened by Carnegie Museum. 3, openings made by F. B. Loomis and subsequently worked by a party from the A. M. N. H. C, "University Hill." 4, quarry opened by Prof. E. H. Barbour.

his account has designated as "Carnegie Hill." Before, however, attacking the task of recovering the remains of this specimen, to which the number 1604 has been attached in the Carnegie Museum Catalog of Vertebrate Fossils, Mr. Utterback

made extensive excavations on the northern face of the hill at the point designated on the map as "Quarry No. 2." Here he found a great many bones belonging to the genus *Moropus* in a disarticulated condition mingled with the remains of other genera. Although these bones were scattered, they have proved of great value in enabling the partial reconstruction of several smaller specimens.

It should be observed at this point that the bones of the large individual found in Quarry No. 1 were not associated with the remains of other specimens belonging to the same genus, except that one or two cervicals of an animal of nearly the same size and belonging to the same genus and species were found here. The specimen No. 1604 lay practically apart, and although the bones were somewhat widely scattered, there has been no difficulty in deciding that they belonged to one individual.

Professor Barbour in 1906 returned to the opening which he had made, and for a short time carried on work with results which were gratifying.

The blocks containing the material collected for the Carnegie Museum were in part worked out in the winter of 1906–7 by Mr. W. H. Utterback, and this work was continued in the spring and summer of 1907 by Mr. S. Agostini and Mr. Peterson. Mr. Peterson, who in July, 1906, had published an account of the Agate Spring Fossil Quarry, which appeared in the Annals of the Carnegie Museum, in December, 1906, published in the Annals of the Museum a paper upon the Miocene Beds of Nebraska and Wyoming, in which he described a number of new species and incidentally gave a brief account of some of the material representing the larger specimen of *Moropus* upon which this Memoir is principally founded.[1]

During the spring and early summer of 1907 Mr. W. H. Utterback, under the instructions of the writer, continued the work of excavation which he had carried on in the previous year, and also made an opening on the eastern face of Carnegie Hill. Toward the close of the season he left the quarries in order to complete the excavation of the skeleton of one of the Ceratopsia which he had located in the fall of the previous year in Converse County, Wyoming, and was called home by the death of his father, after which time his connection with the Carnegie Museum terminated.

After Mr. Utterback had left the spot a party from the American Museum of Natural History entered the excavation made on the eastern side of Carnegie Hill, in which Professor F. B. Loomis of Amherst College had also done some excavating, and worked for a couple of weeks, recovering a quantity of fragmentary material.

[1] Mr. Peterson has treated part of the material used by him in preparing this paper (Specimen No. 1424) as the type of a new species, *M. hollandi*. Science, N. S., Vol. xxxviii, p. 673.

In October, 1907, the writer visited the locality and made a careful examination of the spot and determined that the work of exploration should be further continued during the season of 1908.

In the spring of 1907 the material representing the large specimen of *Moropus* had been freed from the matrix and an effort was at once made to carefully study the specimen. It was gratifying to discover that enough had been recovered with the exception of the cranium and the caudal vertebræ to allow an almost perfect restoration to be made. It is true some of the bones were broken and required minor repairs, and a few were lacking, but there was enough in almost all cases to show plainly what was defective, and where one side of the skeleton failed to give light the other supplied it. In addition the specimens recovered by Mr. Utterback from Quarry No. 2 were sufficiently numerous in some cases to supply perfect specimens representing the missing portions of the larger skeleton; so that in the light of these it was possible with absolute certainty to restore the outlines of missing fragments.

In August, 1907, Mr. Peterson with the consent of the writer read before the International Zoölogical Congress at its meeting in Boston a brief paper upon the anatomy of *Moropus*, based upon the material which had up to that time been recovered, which marks a distinct advance in our knowledge not only of the genus *Moropus*, but of the osteology of the Chalicotheroidea in general.

In the spring of the year 1908 Mr. O. A. Peterson returned to the familiar spot, being earnestly requested to make every effort to secure a complete skull of *Moropus*. With the assistance of a number of able workmen he stripped the western side of the butte on which the work of the Carnegie Museum had already been carried on during the three preceding years, beginning near the point in Quarry No. 1 where Mr. Utterback had ceased operations. Although finding an abundance of the fossil remains of other mammals, Mr. Peterson only recovered a few scattered fragments of *Moropus*. He was on the point of despairing of success in his quest, when, as a last resort, he gave instructions to the workmen to enter the side of the hill at the place where Mr. Utterback had recovered the most of the remains of the large specimen taken up in the fall of 1905 and in the summer of 1906. Mr. Utterback had reported that he had gone into the side of the hill at this spot far enough to satisfy himself that the bone-bearing stratum, to use his expression, had "played out," and to all appearances his report was correct. At the point where he had stopped work no bones were visible. The men digging under the direction of Mr. Peterson had only gone about two feet into the side of the rock when to the great delight of all parties a nearly complete cranium (No.

2103 Carn. Mus. Cat. Vert. Fossils) of a huge *Moropus* was discovered. The specimen was slightly injured by crushing, and lacks the premaxillaries, but was the most perfect cranium of a chalicotherine animal which had thus far been found,

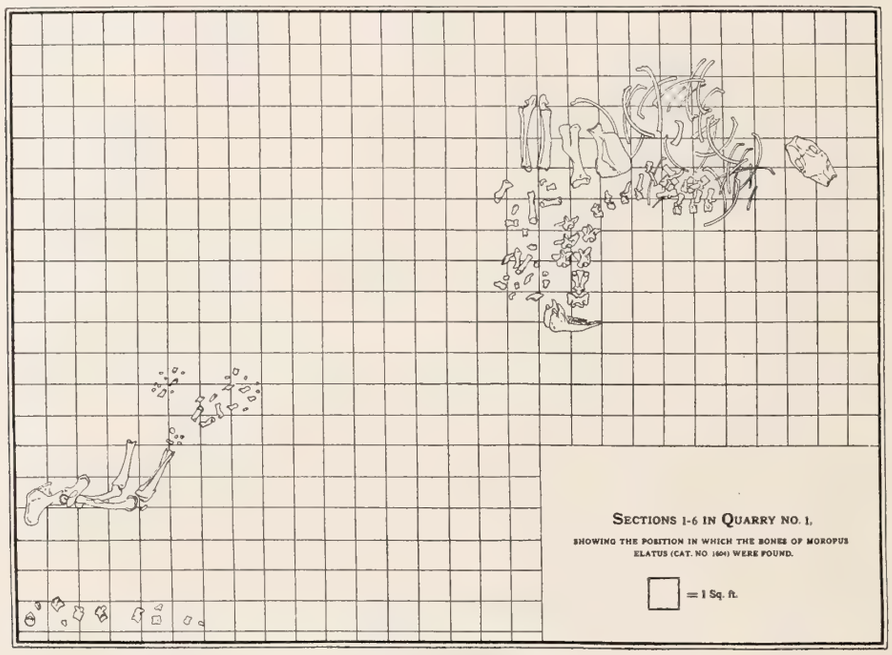


FIG. 2. Sketch of location of bones of *M. elatus* (No. 1604).

surpassing in perfection any specimen in the collections of either America or Europe. That it is the cranium of the large specimen the remainder of the skeleton of which had been recovered in the fall of 1905 and the summer of 1906 does not admit of a particle of doubt. The mandible found by Mr. Peterson in the fall of 1905 exactly fits the cranium discovered in September, 1908. Had Mr. Utterback not reached his conclusion as to the barrenness of the rock so hastily he would have had the pleasure and honor of securing the skull of the animal for the recovery of much of the remains of which in 1906 we are indebted to him.

In September, 1908, the writer again visited the quarries and spent some time in company with Mr. Peterson in the exploration of the region roundabout and in studying the geologic characteristics of the strata, which are here exposed to view. In the present paper these matters will not be referred to, except incidentally.

The "Agate Spring Quarries," as they have been named by Mr. Peterson, are situated in the Lower Harrison Beds (Miocene) and contain a vast quantity of the remains of extinct mammalia many of which, before the specimens were

firmly embedded in the matrix, had suffered more or less displacement. It is rarely that the bones are found collocated in their true order, though in some instances a dozen or more vertebræ may occur in regular series, with the corresponding ribs attached to them, or the bones of an entire limb may be found in place. The region, at the time when the bones were deposited, was probably a great plain, traversed by a broad and shallow river, like the Platte, or the Missouri, subject at times to overflows. It was a region of flat alluvial lands, which may in the summers have been in part dried, leaving here and there pools of water to which the animals of the region resorted, as in South Africa at the present time herds of ungulates resort to such places. Any one who is familiar with the writings of C. J. Anderson and Gordon Cumming can picture to himself the conditions. At these pools the beasts, which roamed over the wide plain, came to drink, and here they died, as the result of age, or as they fell under the teeth and claws of carnivora. It may also have been, as suggested by Mr. Peterson, that at this particular point there was a ford, or crossing of the river, much resorted to by migrating herds of animals, and here many, especially younger animals, were mired in quicksands, and drowned. I have observed an instance, not immediately at the quarries above described, but near by, where the vertical position of the limb bones in the matrix plainly suggested that the animal to which they had belonged had sunk into the sands and had thus been destroyed, leaving its bones at a later age to tell to the curious eye of the passer-by the story of the brief tragedy of its last hours. After a period of summer drought or after the cold of winter, which must likewise then, as it does now, have led to the death of multitudes of creatures, the rivers rose as the result of rains, or melting snows, and the waters swept the dried carcasses of the dead and sometimes those of animals, which, unable to escape from the floods, were drowned, into places where they were destined to lie and become part of the rocky deposits which were in process of formation.

In the Agate Spring Quarry there is abundant evidence of the action of water. Many specimens indeed give no proof that they have been thus subjected to wear and attrition. This was true in the case of the skeleton of the large *Moropus* which is made the basis of this memoir. Its remains, though disarticulated, were not scattered far, and it was not a difficult task to decide that they belonged to one and the same individual. But on the other hand some of the bones found near by were more or less worn by water, especially those in the lower part of the fossiliferous stratum. The large animal was found where it had lain down and died, other bones below it had plainly been previously washed to the spot

or rolled about in the waves, which beat upon the sandy margin of the lakelet or wide river.

The study of the interesting remains, a sketch of the story of the recovery of which has been given in the preceding paragraphs, necessitated an investigation of the entire literature of the subject, as well as the examination of the remains of allied forms preserved in other museums. The material representing the Chalicotheroidea in American collections has until recently been scanty. The type of *Moropus elatus* Marsh at the Yale University Museum consists of a few broken, but recognizable fragments[2] of the bones of the feet. Permission to make casts of them was kindly accorded by the authorities of the Yale Museum. These casts have proved of great service in the determination of the remains obtained in our excavations. To Professor Charles Schuchert and Dr. R. S. Lull I desire to express my thanks for their kindness in this connection. The collection of chalicotherine remains preserved in the National Museum of France in the Jardin des Plantes in Paris is important. I am deeply indebted to the authorities of this museum for reproductions of their material. Professor M. Boule, with that charming kindness which characterizes him, has sent me excellent casts of the type-specimens of *Macrotherium* Lartet, *Schizotherium* Gervais, and *Ancylotherium* Gaudry, which are preserved in the great scientific treasure-house of France. They have been of value in enabling us to make exact comparisons with the remains of the creatures which we have uncovered in Nebraska. To Professor Edmond Perrier and Professor Boule I wish in this connection to renew my heartfelt thanks for all the kindness they have shown me on the occasion of various visits to the French metropolis. I am also indebted to the authorities of the Royal Museum in Munich for casts of the material representing *Nestoritherium* Kaup. = *Ancylotherium* Gaudry, which were used by the late Professor Zittel in illustrating his great Manual of Paleontology. My good friend, Dr. Arthur Smith Woodward, of the British Museum has placed me under obligations by having a reproduction made for me of the cast of the type of *Chalicotherium sivalense* Falconer, which is fortunately preserved in the National Collection in South Kensington. The original is lost, as I shall have occasion to state elsewhere.

[2] In the summer of 1908 Professor H. F. Osborn sent a party from the American Museum of Natural History to the region of the Agate Spring Quarries, and parties from Yale, Amherst, and the University of Nebraska likewise came to the spot. "Where the carcass is, there will the eagles be gathered together." All of them were successful in getting some fragments of *Moropus*, and Professor Osborn's party secured portions of a skull. Since the withdrawal of the Carnegie Museum from the field we understand that the American Museum of Natural History has been operating in the quarries opened by Mr. Peterson and has secured valuable material.

In conclusion I desire to express my appreciation of the knowledge and skill of my associate, Mr. O. A. Peterson, who recovered much of the material, and prepared it for study and description. The constant pressure of executive duties prevented me at times from applying myself to the work of preparing this monograph, and I have therefore, in order to bring it to conclusion, availed myself of Mr. Peterson's services in partly preparing those sections of this paper, which relate to the appendicular skeleton, and to the skull and dentition. Mr. Peterson is justly entitled so far forth to be regarded as a joint author. The painstaking fidelity of Messrs. W. H. Utterback and Mr. S. Agostini in the work of the laboratory deserves to be acknowledged.

Mr. Sidney Prentice with great skill has prepared the drawings. The photographs, which are reproduced, were made by Mr. A. S. Coggeshall.

Finally I cannot conclude these preliminary remarks without giving expression to the sentiments of gratitude which all the members of the paleontological staff of the Carnegie Museum, who have worked in this field, entertain toward Mr. James H. Cook, his most amiable wife, and his sons, who during the whole time during which we were engaged in exploiting the quarries, not only showed intelligent interest in our labors, but accorded to us the most delightful hospitality. Hearty thanks are also due to Mr. John A. Anderson of Harrison, Nebraska, who, refusing all compensation, kindly took charge for a number of winters of our stock and camping outfits, and who has under his hospitable roof from time to time entertained the gentlemen connected with the Museum who have been collecting in the region. Our thanks are also due to Mr. Octave Harris for kind permission during the summer of 1908 to occupy the buildings on his upper or "Castle Rock Ranch," thus providing our party with the most comfortable quarters which they have probably ever possessed on a similar expedition. The genuine "Western hospitality" shown by these gentlemen has endeared them all in memory to their scientific friends from the Carnegie Institute.

CHAPTER I. THE CHALICOTHEROIDEA.

Order **UNGULATA** Ray.

Suborder **PERISSODACTYLA** Owen.

Superfamily *CHALICOTHEROIDEA* Gill (1872).

(*Chalicotherodea* Osborn (1898).)

Principal Characters.—Dentition buno-selenodont; upper incisors unknown; lower incisors three, or wanting; upper canines wanting; lower canines one, or wanting; premolars in all genera so far discovered reduced to three in both jaws; molars three in both jaws; premolar-molar series rapidly increasing in size backwards, especially in the upper jaw; long diastema between premolars and canines or incisors, as in *Equus;* skull ranging from brachycephalic to dolichocephalic in the various genera; auditory bullæ remarkably developed; orbit open posteriorly; supra-orbital with a foramen as in *Equus,* but even more developed; premaxillaries slender; horizontal ramus of mandible narrowing anteriorly, ascending ramus broad and high. Cervical vertebræ so far as known having, as in the *Equidæ,* a prominent keel on the ventral face of the centra, but even more strongly developed than in the latter family. Pelvis, so far as known, elongated, recalling that of the *Artiodactyla.* Third trochanter of the femur either present or absent. The relative length of the fore and hind limbs in some genera subequal, in other genera the hind limbs relatively much shorter than the fore limbs. Distal face of astragalus articulating with the navicular and cuboid, or with the navicular only. Distal extremities of the metapodials on the anterior face having a smooth convex surface for the articulation of the phalanges, on the posterior face provided with a strong median keel separating the sesamoidal facets. First and second phalanges, especially of the second digit of the fore foot frequently coössifying in adult specimens. Terminal phalanges deeply bifid.

For nearly a century paleontologists have been more or less acquainted with the fragmentary remains of a group of curious extinct mammals, which were first found in the Tertiary of Germany and France, later in Greece, and with the progress of exploration in the Tertiary formations of Asia and North America. The first account of a portion of one of these animals was from the pen of the illustrious French naturalist, Baron Georges Cuvier, who in his "Recherches sur les Ossemens Fossiles," Vol. V, pp. 193–195 (1825), gives a description of the cast of a bifid claw-like bone, which had been sent to him by Herr Schleiermacher, the librarian and private secretary of the Grand Duke of Hesse, the original having been found at Eppelsheim. With pronounced firmness of conviction Baron Cuvier announced that this bone undoubtedly belonged to an Edentate, which, according to the analogies of recent forms, must have been "un pangolin gigantesque." "Cet Onguéal n'a d'analogues dans la nature que ceux des pangolins, et d'après toutes les lois de coexistence it est impossible de douter que les rapports les plus marqués de l'animal qui le portoit n'étaient été avec ce genre de quadrupèdes."

In the year 1833 J. J. Kaup ("Ossements Fossiles de Darmstadt," 2me Livraison, p. 6, Pl. 7) erected a new genus under the name *Chalicotherium* (Beast of the Gravel), and referred to it, as the first species, an animal, which in the first Livraison of the same work he had described as *Lophiodon goldfussi*. He also described a smaller form to which he gave the name *Chalicotherium antiquum*. The latter species by some subsequent writers has been regarded as synonymous with *C. goldfussi*. Both of the specimens named by Kaup came from Eppelsheim, the locality at which the ungual described by Cuvier had been found. Kaup recognized the fact that the teeth, which were the skeletal parts upon which his genus was established, were in certain respects similar to those of the *Rhinocerotidæ*. For half a century or more the bones of the feet and the legs of these and allied animals were accepted by comparative anatomists, following the teaching of Cuvier, as belonging to edentate animals, while the bones of their skulls were regarded as belonging to the Ungulata.

In 1872 Professor Theodore N. Gill (Smithsonian Miscellaneous Collections, Vol. XI, p. 71) referred *Chalicotherium* to the Artiodactyla, and erected the superfamily *Chalicotheroidea* for the reception of this and allied forms. Subsequently Professor E. D. Cope placed the Chalicotheriidæ among the Perissodactyla, as one of the families of that suborder. His teachings were accepted at the time without dissent by those who were competent to pass an opinion upon the subject.

In the year 1887 a very curious discovery was made by Mons. H. Filhol, one of the most accomplished and diligent students of paleontology in France. He had for some time been impressed by the fact that although the bones of the feet of *Macrotherium*, which name had been given by Lartet to the supposed "gigantic pangolin," were not uncommon, and the dentition of *Chalicotherium* was tolerably well known, no discovery of the feet of the latter, nor of the head of the former, had been announced. This appeared to him to be the more singular because the remains of the two genera were usually associated with each other in the same strata. He began to suspect that an error had been made in disassociating the two forms. The correctness of his suspicion was remarkably confirmed in 1888 by the discovery at Sansan of the crushed skeleton of a specimen, which being completely isolated from all other material, revealed the limbs and vertebræ of an animal referable to *Macrotherium* associated with the skull of an animal referable to *Chalicotherium* in such relation to each other that no doubt was left in the mind of the discoverer that they belonged to one and the same animal. The conclusion reached by Filhol was supported by the discovery about the same time by Monsieur Charles Depéret in a pocket at Grive-Saint-Alban of a skeleton of *Macrotherium*

associated with a skull of a Chalicothere so located as to leave no alternative to the discoverer but to conclude that the skull and the remainder of the skeleton belonged to each other and represented but one individual.

The discovery that the heads and the feet, so long sundered in the classificatory systems which were in vogue, really belonged together, necessarily raised a number of interesting questions as to the true systematic position of the animals to which they belonged. The Chalicotheres, known by their dentition only, had long been recognized as Ungulates, and as pertaining to the suborder Perissodactyla; but, when it became known that the edentate-like feet must be recognized as forming a part of the structure of the animals, systematists were led to inquire whether perhaps they had not been mistaken in referring *Chalicotherium* and its allies to the Perissodactyla. Professor E. D. Cope very shortly after the announcement by Filhol and Depéret of their conclusions came forward with the proposition to erect a new order for their reception, to which he gave the name *Ancylopoda*.

Professor H. F. Osborn in a paper published in the American Naturalist, February, 1893, with apparent hesitation, accepted Professor Cope's view, but characterizes it as "radical," and, evidently still impressed by the affinities shown by these animals to the Perissodactyla, save as they are possessed of apparently unguiculate phalanges, states that the purpose of his paper is "not to express a final opinion, but to suggest inquiry," and leaves the reader to infer that upon the whole the relationship of this group of animals to the Ungulata, and especially the Perissodactyla, continued to profoundly impress him. Subsequently Professor Osborn in his monograph upon the "Extinct Rhinoceroses" (1898) suggested the subdivision of the suborder Perissodactyla into five superfamilies, the fifth of which he tentatively named the "Chalicotherodea."

The material recovered by the various expeditions of the Carnegie Museum, by means of which we have been able to reconstruct the entire skeleton of one species of the genus *Moropus*, led Mr. Peterson in the paper which he read before the Zoölogical Congress held in Boston in 1907, to advocate with firmness the view that "*Moropus* is, excepting its unguiculate feet, essentially perissodactyl in structure."

The authors of this paper, in the fuller light possessed by them, have resolved accordingly not to accept the more radical view of Professor Cope, and prefer to adopt what they believe to be the preferable course, holding with Zittel and others the view that the Chalicotheres are at most entitled to be regarded as representing a superfamily of the Perissodactyla, to which the name Chalicotheroidea, first proposed by Dr. Gill, must apply. So far as is now apparent, with all the literature

and the material available for study, it seems hazardous to suggest that any other family, except that of the Chalicotheriidæ, is represented by the material thus far recovered by paleontologists.

Since the foregoing paragraphs were written, and were on the point of being sent to the printer, we have received from Professor H. F. Osborn separates of a paper extracted from the Bulletin of the American Museum of Natural History, Vol. XXXII, pp. 261–274 (1913), in which he unqualifiedly accepts the view that the Chalicotheres constitute a superfamily of the suborder Perissodactyla, and in which he also erects the new genus *Eomoropus* for the reception of *Triplopus amarorum* Cope, which he refers to the Chalicotheroidea.

Subfamilies of the Chalicotheriidæ.

A very careful and minute study of the available material has led to the conviction that a subdivision of the family Chalicotheriidæ is necessitated. The subfamilies proposed are the following:

I. The Schizotheriinæ.
II. The Moropodinæ.
III. The Macrotheriinæ.

I. *The Subfamily Schizotheriinæ.*—The type of this subfamily is the genus *Schizotherium* Gervais from the Lower Oligocene of France. With the genus *Schizotherium* we have provisionally associated from purely stratigraphic considerations the genus *Pernatherium* from the Eocene. Coming, as it does, from a lower geological horizon, it seems probable, that, when we shall have recovered enough of its remains to reach definite conclusions as to its foot-structure, we shall find that the same primitive conditions which exist in *Schizotherium* are represented in it also.

The foot of *Schizotherium* shows conclusively that it had a facet on the radial side of Metacarpal II, for the articulation of a vestigial pollex. On the outer surface of Metacarpal IV is a well-defined facet for the reception of the fifth digit. (*Cf.* H. Filhol, "*Observations concernant Quelques Mammifères Fossiles Nouveaux du Quercy,*" Ann. des Sciences Naturelles, Vol. XVI, pp. 142–144 (1894).) In the possession of a fifth digit *Schizotherium* resembles *Moropus,* but the latter genus gives no evidence whatever of the survival in the most vestigial form of a first digit. The Schizotheriinæ are differentiated from the other subfamilies of the Chalicotheriidæ by the fact that they have retained in the structure of the manus evidence of their descent from a primitive pentadactyl ancestry, having the articulating facets for the thumb and the fifth finger.

To the Schizotheriinæ may also be provisionally referred the new genus *Eomoropus* Osborn from the Eocene of North America, and *Phyllotillon* Pilgrim, from the Oligocene of India. There is no evidence in *Eomoropus* of the retention of the pollex, but the fifth digit has not been nearly so much reduced as in *Moropus*. This genus probably represents a transition from the pentadactyl form in the direction of *Moropus*, which is functionally tridactyl. *Phyllotillon* is placed in this subfamily from purely stratigraphic considerations.

II. *The Subfamily Moropodinæ.*—Professor O. C. Marsh with only a few fragments before him ventured, on what we now know to have been very insufficient grounds, to set up the family Moropodidæ, with the genus *Moropus* as the type. It was a shrewd guess, which somewhat overshot the mark. Nevertheless, now that we have acquired a nearly complete knowledge of the osteology of the genus *Moropus*, it becomes very plain that we have good ground for separating it, and the somewhat closely allied *Nestoritherium* (*Ancylotherium, auct.*) of Europe from the other genera of the family, for the following reasons: (1) in both these genera the astragalus does not touch the cuboid, a primitive feature; (2) the fifth digit persists in the manus of *Moropus*, though in *Nestoritherium* so far as material at present available seems to show, it has been lost; (3) both *Moropus* and *Nestoritherium* were characterized by having the fore and hind limbs more nearly subequal, than is the case in *Macrotherium;* (4) the articulating surface of the radius at its distal extremity is widened laterally and compressed in the antero-posterior direction in both genera, while in *Macrotherium* this surface is nearly quadrate. There are a number of other minor points of similarity between *Moropus* and *Nestoritherium*, which taken together show that they were more nearly related to each other than to the other genera of the family.

III. *The Subfamily Macrotheriinæ.*—Gervais recognized the family "*Macrotheridæ*" (*cf.* Journal de Zoölogie, Vol. V, No. 6, p. 426). Following this as a precedent we have adopted the name here given for the third subfamily of the Chalicotheriidæ. To it we refer the genera *Macrotherium*, *Chalicotherium*, and *Circotherium*, gen. nov. These three genera are derived from later geological horizons than *Schizotherium*, *Macrotherium* being derived from the Miocene of Sansan, France, *Chalicotherium* from the Pliocene of Eppelsheim, Germany, and *Circotherium* from the Upper Miocene or Pliocene of the Siwalik Hills in India. In *Macrotherium* we find no trace whatever of the first and fifth digits. The manus of *Chalicotherium* is practically unknown, but its geological horizon is such as to seem to justify the belief that it probably did not retain these primitive features; in other respects, such as dentition, it is closely related to *Macrotherium*. The

characters which appear to justify the erection for these genera of a subfamily in addition to the entire absence of the first and fifth digits, are the following: (1) in *Macrotherium*, and presumably in the other genera the astragalus articulates with both the cuboid and the navicular, a distinctively perissodactyl feature; (2) the hind limb in *Macrotherium* is relatively much shorter than the fore limb; (3) so far as is known, all of these genera are characterized by a noticeable shortening of the muzzle, through a reduction in the length of the premaxillaries and the anterior portion of the mandible.

While we feel justified in erecting the foregoing subfamilies for the reception of the genera, which are the types of each, viz.: *Schizotherium*, *Moropus*, and *Macrotherium*, it must be understood that the reference of the other genera which have been placed in these subfamilies is of necessity more or less provisional, because of the lack of material which would permit of more accurate determinations in some respects. Unfortunately our knowledge of some of these genera is very insufficient, they being in a number of cases merely represented by fragments which do not permit of exact comparisons between corresponding parts of the skeleton. We know enough, however, to be able to affirm with emphasis, that a distinct evolutionary process has taken place in these forms, and those from later geological horizons show marked differences in their anatomical structure from those derived from the earlier formations, differences so great as to fully justify their recognition in the manner we have adopted.

CHAPTER II. THE GENERA OF THE CHALICOTHEROIDEA.

Family CHALICOTHERIIDÆ Gill.

Subfamily SCHIZOTHERIINÆ subfam. nov.

Genus Schizotherium Gervais.

Gervais, Zoölogie et Paléontologie Générales, 2me Ser., Livr. iii, pp. 58–59 (1876).

Synonym *Limognitherium* Filhol, Comptes Rendus, Vol. XC, p. 1580 (1880). *Cf.* Filhol, Ann. des Sc. Nat., Vol. XVI, p. 145 (1894).

Type: *S. priscum* (Gaudry). Comptes Rendus, Vol. LXXXI, pp. 1036–38 (1875); Journal de Zoölogie, Vol. IV, p. 519, 523, Pl. XVIII (1876); *cf.* Filhol, Ann. des Sc. Nat., Vol. XVI, pp. 141–148 (1894).

Type Specimens: A fragment of the left maxillary containing the premolars and the two anterior molars, metatarsals, metacarpals, phalanges.

Location of Types: Musée National d'Histoire Naturelle, Paris. (Casts in the Carnegie Museum.)

Geological Horizon: Phosphorites of Quercy (Lower Oligocene).

Generic Characters: Dentition $I\frac{?}{?}$, $C\frac{?}{?}$, $P\frac{3}{3}$, $M\frac{3}{3}$; upper molars longer than broad; trapezium present; facet for vestigial pollex; Mc. II and IV comparatively long when compared with *Moropus;* Mc. V present; Mt. III and IV subequal in length.

Genus Pernatherium Gervais.

Gervais, Journal de Zoölogie, Vol. V, No. 6, pp. 424–432 (1876).

Type: *P. rugosum* Gervais, *l. c.*

Type Specimens: Os calcaneum and fragments of metapodials described by Gervais.

Location of Types: Musée National d'Histoire Naturelle, Paris.

Geological Horizon: Marls of Saint-Ouen, near Parc de Monceaux (Eocene).

Generic Characters: Dentition unknown; the distal articulation of one of the two fragmentary metapodials shows rather conclusively that Gervais was not mistaken in referring the animal to the Chalicotheriidæ. The material is, however, very insufficient, and quite inadequate to base upon it a correct diagnosis of the genus. The proximal end of a metapodial reveals three articulating surfaces separated from each other by sulci, rising externally from the upper end of the shaft, one of which surfaces is apparently in part supported upon a columnar process, a feature which is not revealed in any other genus of the family, so far as is now known. The os calcaneum also shows marked differences from the corresponding bone in other genera in the shape of the articulating surfaces. Unfortunately until the present time no material other than the types has been discovered. We place this genus in the subfamily *Schizotheriinæ* simply on account of its geological horizon. It may well represent, however, a totally different group of primitive ungulates, related to the Chalicotheroidea. Until more and better material is discovered its true affinities must remain more or less problematical.

Genus Eomoropus Osborn.

Osborn, Bulletin American Museum of Natural History, Vol. XXXII, p. 264, (1913).

Type: *Triplopus amarorum* Cope, Proceedings American Philosophical Society, Vol. XIX, p. 389 (1881); *cf.* Vertebrata of the Tertiary Formations of the West, I, pp. 660, 687, Pl. LV, figs. 6–9, Pl. LVIII, fig. 2 (1885).

Type Specimens: Cranium, lower jaw, three cervicals, limb bones, carpus, and tarsus.

Location of Types: Cope Collection, American Museum of Natural History.

Geological Horizon: Washakie, Wyoming (Upper Middle Eocene).

Generic Characters: "Premolar crowns *simple*, premolar conids without metastylids, large hypoconulid on M_3, fibula greatly reduced" (Osborn).

Genus Phyllotillon Pilgrim

Pilgrim, "Notices of New Mammalian Genera and Species from the Tertiaries of India." Rec. Geolog. Survey of India, Vol. XL, pp. 634–640 (1910).

Type: *Macrotherium naricum* Pilgrim, Rec. Geolog. Survey of India, Vol. XXVII, p. 156 (1908).

Geological Horizon: Nari Beds, Bugti Hills (Aquitanian *fide* Pilgrim, Oligocene (?)).

Generic Characters: "*Phillotillon naricus* n. gen. This name is to replace *Macrotherium naricum*, a Chalicotheroid from the Nari series of the Bugti Hills. The new genus differs from the other members of the family by the greater elongation of its molars, but chiefly by the fact that in the upper premolars the large inner cusp is united to the ectoloph by a double instead of a single crest." Pilgrim, *l. c.*

This very brief account of the genus leaves us in doubt as to the meaning of the author. "The large inner cusp of the premolars" is connected with the ectoloph by *two* crests in the case of many of the Chalicotheroids, the dentition of which is known, *e. g. Schizotherium*, *Moropus*, and *Macrotherium*. If the writer in the use of the word "double" means to indicate that there are two such crests, the generic value of the distinction disappears altogether. If, however, he means to point out that these two crests are double, that is to say showing duplicated parallel ridges on their upper projecting summits, such a fact might well indicate a generic difference, as such a conformation of these teeth has never hitherto been pointed out by any one. Without more exact information on this subject the new genus is only accepted in a provisional manner. It is placed among the *Schizotheriinæ* because it apparently comes from the Oligocene, and therefore may be associated with and related to the earlier forms.

Subfamily MOROPODINÆ subfam. nov.

Genus Moropus Marsh.

Marsh, American Journal of Science and Arts, Ser. III, Vol. XIV, pp. 249–251 (1877).

Type: *M. distans* Marsh, *l. c.*, p. 249.

Type Specimens: Professor Marsh described three species in his paper, the first of which, *M. distans*, according to the accepted laws of nomenclature becomes the type of the genus. Unfortunately the type is extremely inadequate, consisting simply of a cuboid, coössified first and second phalanges, and median phalanx. The material, which is generically, but not specifically, determinable, without doubt pertained to an animal which was probably not more than half the size of *Moropus elatus*. (First figured by Peterson, American Naturalist, Vol. XLI, p. 735 (1907).)

Location of Types: Peabody Museum of Natural History, Yale University, New Haven, Connecticut. (Casts of types in Carnegie Museum.)

Geological Horizon: John Day Beds, Oregon (Miocene).

In addition to *M. distans* Professor Marsh described two other species which he referred to the same genus, *M. senex*, from the John Day Beds, and *M. elatus*, which he attributed, as we now know in error, to "the Lower Pliocene of Nebraska." The latter species, which came from the Lower Miocene of Nebraska, is the basis of the present paper, and the question of the geological horizon from which it came as well as its osteology will be taken up at length in succeeding pages. It suffices to say here that there is no evidence that *M. elatus* has been found elsewhere than in the Lower Harrison Beds of Nebraska (Lower Miocene). Other species have been found in later horizons.

Generic Characters: Dentition $I\frac{?}{3}$, $C\frac{0}{0}$, $P\frac{3}{3}$, $M\frac{3}{3}$; molars longer than broad, hypsodont, their external walls, as in *Nestoritherium*, more nearly vertical than in *Macrotherium* and *Chalicotherium*, in which genera the external walls are bent inwardly so that in unworn molars they present a surface almost horizontal extending inwardly to the middle of the tooth; the vertical crests of the ectoloph sharp; skull long and relatively narrow; the anterior margin of the posterior nares on the median line well back of the posterior margin of the last molar; fore feet tetradactyl (fifth digit greatly reduced); trapezium present; Mc. III longest; dorsal surface of metacarpals straight longitudinally, not concave longitudinally as in *Nestoritherium;* distal face of astragalus

articulating with navicular only; Mt. III and IV of subequal length; fibula sometimes articulating with the os calcaneum; third trochanter of the femur strongly developed; fore and hind limbs more nearly of equal length than in *Macrotherium*.

The foregoing generic characters are based upon the material representing *Moropus elatus*. It should not, however, be forgotten that *Moropus distans* from the John Day Beds of Oregon is the first species named by Marsh in his description of the genus, and is therefore the genotype. *M. distans* was a much smaller animal than *M. elatus*, even smaller than *M. petersoni*, and it may be that with the progress of discovery it will be found to be very different structurally from the animals represented in the Lower Miocene of Nebraska, so much so as to justify the generic separation of the latter.

Genus Nestoritherium[3] Kaup.

Kaup, Beiträge, Heft IV, p. 3 (1859). (Type *R. pachygnathus* Wagner, *partim* = *M. pentelicum* Gaudry.)

Synonym *Ancylotherium* Gaudry, *Animaux fossiles et Géologie d'Attique*, pp. 129–142 (1863).

Type: *Macrotherium pentelicum* Gaudry et Lartet, Comptes Rendus de l'Acad. des Sciences, Vol. XLIII, p. 271 (1856) = *Rhinoceros pachygnathus* (Wagner)

[3] Wagner, in the Abhandlungen d. K. Bayer. Akademie d. Wissenschaften, II. Kl., Vol. V, Abth. II, pp. 349 *et seq.* (1854), describes the remains of a rhinoceros, to which on Plate X (Tafel 2), Figs. 3, 4, and 5, and on Plate XI (Tafel 3) he applied the name of *Rhinoceros pachygnathus*. Subsequently, in 1857, in the same publication, Band VIII, Abth. I, p. 28 *et seq.*, he describes a fragmentary skull, the left superior dentition of which he figures on Pl. VII, Fig. 15, to which he also applies the name of *Rhinoceros pachygnathus* (see our Fig. 3, which is drawn from a cast of the type). Later, in 1859, Kaup, recognizing that the dentition figured by Wagner (*l. c.*) did not pertain to a rhinoceros, but to a Chalicotheroid, erected the genus *Nestoritherium* for its reception. Falconer, writing from Munich, June 15, 1861 (see "Paleontological Memoirs and Notes of the late Hugh Falconer, A.M., M.D.," etc., p. 223), says: "Most interesting of all the Pikermi collection are a set of specimens of a very large species of the same genus as our Sewalik *Chalicotherium*. This is the *Nestoritherium* Kaup (Beiträge, viertes Heft, 1859), which is figured and described under the name *Rhinoceros pachygnathus* by Wagner (1857). The principal specimen, Fig. 15, Plate VII, execrably drawn, consists of the greater part of a cranium," etc. He then goes on to describe this specimen. It is thus clearly established that the *Nestoritherium* of Kaup was founded upon the Munich skull, which is undoubtedly referable to *Ancylotherium pentelicum* (Gaudry et Lartet), with which it has been identified by Zittel and others. The specimen is slightly smaller in size than the specimen in Paris, but, so far as comparison permits, identical. Both came from Pikermi. The genus *Ancylotherium* Gaudry was not proposed by the latter author until the year 1863 (*cf.* "Animaux fossiles et Géologie d'Attique," pp. 129 *et seq.*). From the foregoing it is seen that the generic name *Nestoritherium* has priority over *Ancylotherium*, the type species being *pachygnathum* Wagner, a homonym, which must be dropped according to the laws of nomenclature, and replaced by *pentelicum* Gaudry et Lartet, which is identical, and also has priority.

partim Abhandlungen des K. Bay. Akad. d. Wissenschaften, II. Kl., Bd. VIII, Abth. I, pp. 28 *et seq.*, Pl. VII, fig. 15 (1857) (*nec R. pachygnathum* Wagner 1854).

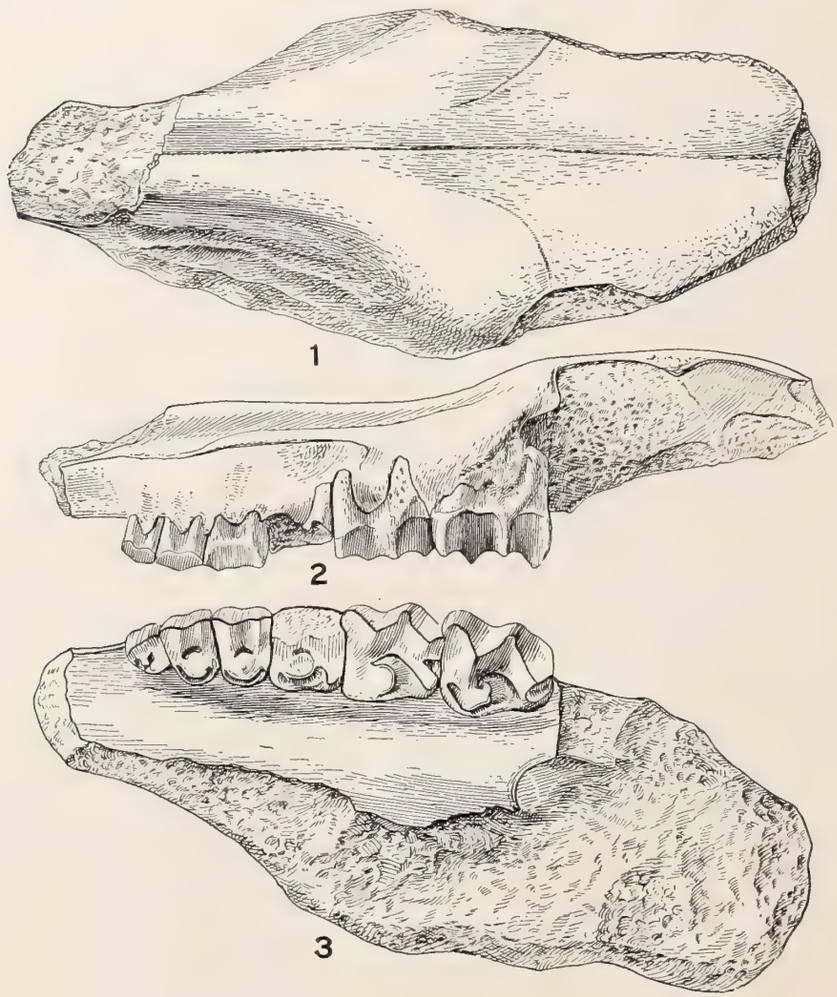


FIG. 3. Type of *Nestoritherium* Kaup. Being the skull of the specimen from Pikermi preserved at Munich, the dentition originally figured by Wagner as in part that of *Rhinoceros pachygnathus*.

Type Specimens: Humerus, radius, ulna, and fragment of a metacarpal, phalanges of fore feet, and part of hind foot, preserved in Paris. Fragmentary skull (*Rhinoceros* (*Colodus*) *pachygnathus*, the dentition figured by Wagner), lower jaws, distal ends of radius and ulna, carpus, proximal ends of metacarpals, preserved in Munich. (Casts of all these specimens are in the Carnegie Museum.)

Location of Types: Musée National d'Histoire Naturelle, Paris, and Staats

Museum, Paläontologische Sammlung (Neuhäuserstrasse 51), Munich.

Geological Horizon: Pikermi, Greece (Upper Miocene).

GENERIC CHARACTERS: Dentition $I\frac{?}{?}$, $C\frac{?}{?}$, $P\frac{3}{3}$, $M\frac{3}{3}$; last two upper molars longer than broad, hypsodont, with vertical crests of ectoloph sharp, the external walls more nearly vertical than in *Macrotherium* and *Chalicotherium;* skull long, but not narrowing in front as much as in *Moropus;* the anterior margin of the posterior nares on the median line opposite the anterior edge of the posterior lobe of the last molar; carpus relatively low; trapezium present[4] (?); manus and pes tridactyl; the anterior surface of the metacarpals longitudinally concave, and the shafts more nearly trihedral in cross-section than in *Moropus.* The transverse diameter of the distal end of the radius is relatively much greater than in *Macrotherium,* the articulating surface in the latter genus being nearly quadrate, while in *Nestoritherium* as well as in *Moropus* this surface is oblong, with the antero-posterior diameter not more than half the transverse diameter (*cf.* Depéret, Mammifères Miocènes de la Grive-Saint-Alban, p. 71). The distal face of the astragalus articulates with the navicular only; Mt. III is the longest, whereas in *Moropus* the metatarsals III and IV are more nearly subequal.

Subfamily MACROTHERIINÆ subfam. nov.

Genus MACROTHERIUM Lartet.

Lartet, Comptes Rendus des Séances de l'Académie des Sciences, Tome IV, pp. 85–93 (1837).

Synonym *Anisodon* Lartet, Notice sur la Colline de Sansan, p. 30 (1851).

Type: *M. grande* Lartet (Grande Anoplotherium), Comptes Rendus, *l. c. Cf.* Gervais, Zoölogie et Paléontologie Francaises, 1re Ed., Tome I, p. 91; 2me Ed., Tome I, p. 169 (1859).

Type Specimens: Fragments originally obtained by Lartet, the dentition referred by him to his "grande *Anoplotherium,*" the foot-bones attributed to the "pangolin gigantesque" of Cuvier. This scanty material was subsequently augmented by specimens obtained at the same locality, and undoubtedly representing the same species, which were studied, described and figured by Gervais under the name *M. giganteum.* The restoration of the fore and

[4] A careful examination of the specimen preserved in Munich plainly suggests that the trapezium must have been present, though it is not preserved in the specimen. The facets on the radial face of Mc. II appear to indicate articulating surfaces for this bone.

hind foot effected by Gervais from this material has been accepted for more than half a century as correct, and his drawing, first published in the Journal de Zoölogie, Tome VI, Pl. II, has been reproduced in almost all text-books on paleontology published since his day. Gervais, led by the belief, which prevailed at the time, that these animals were edentates, attempted in his restoration to give to the feet a plantigrade position. He completely ignored the articulating surfaces for the large sesamoids, of the existence of which he had no knowledge, and forced the proximal articulating surfaces of the phalanges over the carina separating the sesamoids, an impossible position. He also made the evident mistake of attaching the largest ungual phalanx to digit IV, thus imparting to his restoration an exaxonic appearance. In the figures here given (Fig. 4) we have reproduced the restoration made by Gervais as it is given in Zittel, Handbuch d. Palæontologie, Bd. IV, p. 312, and a restoration in which we have employed the casts of the material used by Gervais, collocating them after the analogy of the manus of *Moropus*. The theory that the feet of the Chalicotheroids were exaxonic must fall. The main axis of the manus, supporting the stress of the body, was through the lunar, the magnum, and metacarpal III, the feet being diplarthrous, and mesaxonic.

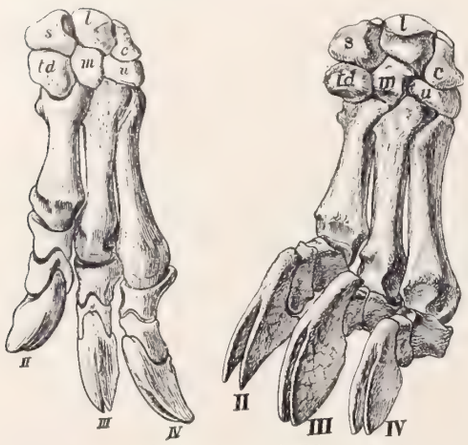


Fig. 4. Left forefoot of *Macrotherium* as restored by Gervais (to the left) compared with the same foot as it should be placed (to the right).

Location of Types: Musée National d'Histoire Naturelle, Paris. (Casts of all this material are contained in the Carnegie Museum.)

Geological Horizon: Sansan, Gers, France (Miocene).

Generic Characters: Dentition $I\frac{?}{3}$, $C\frac{?}{1}$, $P\frac{3}{3}$, $M\frac{3}{3}$; length and breadth of superior molars subequal, external walls bent inwardly, vertical crests more rounded than in *Moropus* or *Ancylotherium;* humerus relatively slender, radius and ulna relatively long in comparison with other genera; distal articulating surface of radius subquadrate, not transversely elongate as in *Moropus* and *Nestoritherium;* Mc. IV and Mt. IV longer than the other metapodials; tibia proportionally short; Mc. V wanting; trapezium absent; astragalu slow, broad, articulating with both the navicular and the cuboid; pes relatively short.

Genus Chalicotherium Kaup.

Kaup, "Description d'Ossements Fossiles de Mammifères Inconnus Jusqu'à Présent, qui se trouvent au Muséum Grand-Ducal de Darmstadt," etc., Second Cahier, pp. 4–8 (1833).

Type: *C. goldfussi* Kaup, *l. c.*

Type Specimens: One upper and one lower molar described and figured by Kaup, also a canine, which is now known not to have belonged to the same animal, and is totally unlike what we know of that tooth in this and other Chalicotherine genera. Subsequently other specimens were found in the same general locality, and these are preserved in the Museum at Darmstadt, and being referable without doubt to the same species, and dating from the time of Kaup, are regarded as neo-typical.

Location of Types: Grand-Ducal Museum in Darmstadt. (Casts in the Carnegie Museum.)

Geological Horizon: Eppelsheim, Germany (Upper Miocene).

Generic Characters: Dentition $I\frac{?}{?}$, $C^5\frac{?}{?}$, $P\frac{3}{3}$, $M\frac{3}{3}$; upper molars broader than long, the molar series being relatively shorter than in *Macrotherium*, and much shorter than in *Moropus* or *Nestoritherium;* crowns brachyodont, the outer walls bent inwardly as in the preceding genus, and the vertical crests of the ectoloph gently rounded; proximal phalanx short, relatively shorter in the shaft than in *Macrotherium*, depressed, broad; ungual high and laterally compressed as in *Macrotherium*.

Genus Circotherium[6] gen. nov.[7]

Type: *Chalicotherium* (*Anoplotherium*) *sivalense* (Falconer & Cautley), Transactions of the Geological Society of London, Vol. V, p. 502 (1837); Fauna Antiqua Sivalensis, VIII, Pl. 80 (1847); Paleontological Memoirs and Notes of the late Hugh Falconer. etc., by Charles Murchison, Vol. I, p. 208, Pl. 17 (1868).

[5] The canine figured by Kaup, as has already been pointed out, does not belong to the *Chalicotheroidea.*

[6] κίρκος = *a falcon*, in playful reference to the name of Dr. Falconer; θηρίον = a wild beast.

[7] The generic identification of *Nestoritherium* Kaup, founded upon the specimen from Pikermi, with *Chalicotherium sivalense* (Falconer and Cautley), made by Falconer on the occasion of his visit to Munich in 1861, and apparently accepted by Lydekker in his Catalogue, is not, in the light of our studies, one which can stand. We regret very much to be compelled to add another generic name to those which have been employed in designating the Chalicotheres, but as the type of *Nestoritherium*, as has already been pointed out, is undoubtedly the specimen in Munich (= *pentelicum* (Gaudry et Lartet)), the Indian species, which is characterized by a brachycephalic skull and by having a canine in the lower jaw which is not found in *Nestoritherium*, so far as existing material shows, must be separated generically, as we have done.

Location of Types: The fragments of the upper and lower jaws, described and figured in the papers cited above, formed a part of the Cautley Collection, and are preserved in the British Museum. The anterior portion of the skull likewise figured and described in the same papers, being a part of the Dadapoor Collection of Messrs. Baker and Durand, was deposited in the Museum of Marischal College, Aberdeen, and has been lost. The writer made diligent effort some years ago to obtain a sight of this specimen, and finally having enlisted the assistance of Dr. A. Smith Woodward, ascertained through him, as the result of his correspondence with the authorities of the College, that it is "reported" that certain "old bones," which once were in the Museum of Marischal College, had been thrown out, and "buried in the flower-beds in the court of the College." Dr. Woodward in a letter to the writer jocosely suggested a journey to the spot for the purpose of undertaking excavations in quest of the types of the Indian fossils described by Falconer, but so far I have not heard of his having taken the journey. Very fortunately a cast of this anterior portion of the interlocked cranium and the lower jaws made long ago, exists in the British Museum, where I have examined it; and a copy of this cast was with the greatest kindness prepared and presented to the Carnegie Museum through Dr. Woodward, acting on behalf of the Trustees of the British Museum.

Geological Horizon: Siwalik Hills, India (Pliocene).

Generic Characters: Dentition $I\frac{0}{0}$, $C\frac{0}{1}$, $P\frac{3}{3}$, $M\frac{3}{3}$; the published figures of the original specimen (*cf.* Falconer and Cautley, *ll.cc*) suggest the presence of alveolar openings for incisors, but the emphatic statement of Falconer that "there is not a trace [of the incisors] even in the most rudimentary form" leaves no doubt that they were wanting both in the upper and lower jaws. The lower canine is well developed and strong. M^1 is broader than long, as in *Chalicotherium;* M^2 is longer than broad; M^3 as broad as long, as in *Macrotherium.* The premaxillaries are short and delicate. The anterior extremity of the mandible is greatly reduced in length in comparison with *Moropus,* the symphysis of the lower jaw is heavy, tapering very rapidly to the thin edentulous incisive alveolar border. The remains of the skull and dentition show clearly that the animal must have had a very short muzzle, was brachycephalic, and not dolichocephalic, as *Moropus* and *Nestoritherium.*

GENERA AND SPECIES WHICH HAVE BEEN FORMERLY REFERRED TO THE CHALICOTHEROIDEA.

Genus Colodus Wagner.

Wagner in the Abhandl. d. K. Bayer. Akademie d. Wissenschaften, Band V, Abtheil. II, described *Rhinoceros pachygnathus*, and figured on Plate X, figs. 3 and 4, the fragmentary lower jaw of a specimen, which undoubtedly pertained to a rhinocerotid. In the same journal, Vol. VIII, Pl. VII, fig. 15, he figures a portion of the dentition of a Chalicothere which he ascribes to *Rhinoceros pachygnathus*, still preserved in the Museum at Munich, and represented by a cast in the Carnegie Museum. This specimen was the type of *Nestoritherium* Kaup. Subsequently (Sitzungsberichte d. K. Bayer. Akad. d. Wiss., Vol. II, pp. 81–82 (1861)) Wagner erected the genus *Colodus* for the reception of *Rhinoceros pachygnathus*. As the type specimen upon which he originally founded the species *Rhinoceros pachygnathus* is a true rhinoceros, the genus *Colodus* has been very properly accepted by Zittel and others as belonging to the Rhinocerotidæ, and by Zittel is regarded as a synonym of *Atelodus* Pomel. The erroneous reference of the superior dentition of a Chalicotheroid to *Rhinoceros pachygnathus* does not constitute a valid ground for regarding the generic name *Colodus*, afterwards applied to the species, as applicable to the Chalicothere from Pikermi, to which Kaup gave the name *Nestoritherium*. *Colodus* must be restricted to the Rhinocerotidæ, as the original type belonged to this family.

Genus Dæodon Cope.

Though originally referred by Cope to the Chalicotheriidæ, it is an Entelodont. *Cf.* Peterson, Memoirs Carnegie Museum, Vol. IV, p. 63 (1909).

Genus Homaladotherium Flower, Proceedings of the Royal Society of London, Vol. XXI, p. 383 (1873).

This name suggested by Huxley in his Annual Address before the Geological Society of London, which was reported in the *Quarterly Journal* of that Society, Vol. XXVI, p. lvii (1870), but which is *nomen nudum*, was first given standing by Flower (*l. c.*). It since has undergone a number of mutations in spelling. Flower himself in 1874 gave it as *Homalodontotherium*, Burmeister in 1891 as *Homalodon*, and Florentino Ameghino in 1906 employs *Homalotherium*.

The specimens described by Sir William Flower were the same to which Professor Huxley had referred in his address. Ameghino in the Anales del Museo

Nacional de Buenos Aires, Tomo XV, p. 317 *et seq.*, places his *Homalotherium segoviæ* in the Ancylopoda, and points out certain very remarkable features of the structure of the foot, which suggest that this form is related to the Chalicotheroidea. However the dentition and other features show that aside from the bifid condition of the unguals the animal had little in common with the Chalicotheres, a fact which has been well set forth by Gregory in his recent work to which reference has been made. Bifidity of the unguals is not confined to the Chalicotheroidea, as is well known to all students of comparative anatomy. It is a primitive structural feature, traces of which may be found in many widely separated families and genera. To point out these would necessitate the writing of a chapter, for which there is not space in the present memoir.

Hyracotherium craspedotum Cope, Bull. U. S. Geol. Survey, VI, p. 198 (1881). Now referred to the Equidæ.

Hyracotherium venticolum Cope, Bull. U. S. Geol. Survey, VI, p. 198 (1881). Now referred to the Equidæ.

Hyracotherium vortmani Cope, Bull. U. S. Geol. Survey, VI, p. 198 (1881). This species was by Cope, *l. c.*, p. 199, referred to *Phenacodus*, and is still regarded as belonging to the Phenacodontidæ.

Lambdotherium popoagicum Cope, American Naturalist, Vol. XIV, p. 746 (1881), and *L. brownianum* Cope, *l. c.*, p. 197, are both referred to the Titanotheres.

Genus Meniscotherium Cope, Report upon Vertebrate Fossils Discovered in New Mexico, p. 8 (Nov., 1874).

In the paper here cited Professor Cope erected a new genus under the above name, the type being the species described by him under the name *chamense*. Professor H. F. Osborn in a paper published in the American Naturalist, February, 1893, pp. 118–133, in discussing the relationship of the various genera of the Ancylopoda calls attention to the fact that in *Meniscotherium* the same reduction in the anterior portion of the dental series and the same enlargement of the posterior portion, which is noticeable in the Ancylopoda, occurs, and also that the molars of *Meniscotherium* in both jaws have the same pattern as those of the Chalicotheres. He therefore suggests that *Meniscotherium* was perhaps in the line of the ancestry of the Ancylopoda. Subsequent studies which have resulted in the almost complete restoration of the skeleton of *Meniscotherium*, have demonstrated to the satisfaction of students that the resemblances in the dentition of *Meniscotherium* and the Chalicotheroidea, while pointing possibly to a remote common ancestry, do not suffice to establish the fact that *Meniscotherium* was ancestral to the Chali-

cotheres. Dr. Gregory in his recent valuable work upon "The Orders of Mammals" has clearly pointed out this fact. The Meniscotheriidæ are now accepted as a family of the Condylarthra.

Oligotomus osbornianus Cope, Proc. Am. Phil. Soc., Vol. XX, p. 182 (1881) was made the type of the genus *Ectocion* by Cope, American Naturalist, Vol. XVI, p. 522, and is now referred to the *Phenacodontidæ*.

Genus Sphenocœlus Osborn, Bulletin American Museum of Natural History, Vol. VII, p. 98 (1895).

The specimen, to which Dr. Osborn gave the specific name *uintensis*, came from Wagonhound Canyon, Uintah County, Utah. The specimen consists of the posterior portion of a cranium, which Dr. Osborn with hesitation and doubt referred provisionally to the *Chalicotheriidæ*, but which, until more and better material is obtained, must be regarded as *incertæ sedis*.

Systemodon Cope, gen. nov., American Naturalist, XV, p. 1018 (1881).

The type of the genus selected by Cope was *Hyracotherium tapirinum*, which is now referred to the Equidæ.

Systemodon semihians Cope, Proc. Am. Phil. Soc., Vol. XX, p. 184 (1881). This species is now referred to the *Tapiridæ*.

CHAPTER III. THE SPECIES OF THE CHALICOTHEROIDEA.

It is not the purpose of the brief resumé which we are giving in this part of this memoir to do more than indicate the salient facts as to our present knowledge of the classification of the Chalicotheroidea, nevertheless it has appeared to us that it may add value to this paper to incorporate at this point a list of the species of the Family Chalicotheriidæ which have hitherto been named. This is done without positively affirming anything as to their validity, except in the case of those species, which are accepted as genotypes. This is more particularly true in the case of the European species. To have undertaken to look up all the types, often fragmentary, and in some cases specifically unidentifiable, which are scattered through European collections, would have required more time than has been at the command of the senior author, when in Europe. In reference to the species of American origin we can speak more confidently.

LIST OF SPECIES[8] BELONGING TO THE CHALICOTHEROIDEA.

Family CHALICOTHERIIDÆ.

Subfamily SCHIZOTHERIINÆ.

Genus Schizotherium Gervais.

1. *S.* †*priscum* (Gaudry), Journal de Zoölogie, Vol. IV, p. 519 (1875).
   Phosphorites of Quercy (Oligocene).
2. *S. modicum* (Gaudry), *l. c.*, p. 523 (1875).
   Phosphorites of Quercy (Oligocene).
3. *S. ingens* (Filhol), Comptes Rendus, Vol. XC, p. 1580 (1880).
   Phosphorites of Quercy (Oligocene).
4. *S. wetzleri* (Kowalesky), Palæontographica, Vol. XXII, p. 250, Pl. VIII, figs. 74*d*1–74*d*4 (1876).
   Eggingen, Germany (Oligocene).
5. *S. schinzi* (H. von Meyer) *fide* Trouessart. *Ubi descript.* ?[9]
6. *S. sp*? Pilgrim, Rec. Geol. Survey of India, Vol. XL, p. 67 (1910).
   Nari Beds, Bugti Hills (Aquitanian *fide* Pilgrim. Oligocene?).

Genus Pernatherium Gervais.

1. *P.* †*rugosum* Gervais, Journal de Zoölogie, Vol. V, No. 6, pp. 424–432 (1876).
   Marls of Saint-Ouen (Eocene).

Genus Eomoropus Osborn.

1. *E.* †*amarorum* (Cope), Proceedings American Philosophical Society, Vol. XIX, p. 389 (1881).
   Washakie Beds, Wyoming (Upper Middle Eocene).

Genus Phyllotillon Pilgrim.

1. *P.* †*naricum* (Pilgrim), Rec. Geol. Survey of India, Vol. XXVII, p. 156 (1908).
   Nari Beds, Bugti Hills (Oligocene).

[8] A dagger before the specific name indicates the genotype.

[9] A search of all the literature available has failed to reveal the location of the original description of *Anisodon schinzi* von Meyer, which is cited by Trouessart without reference to the title and date of the paper in which it appeared.

Subfamily MOROPODINÆ.

Genus Moropus Marsh.

1. *M. oregonensis* (Leidy), "The Extinct Vertebrate Fauna of the Western Territories," p. 219, Pl. II, fig. 1 (1873). *Lophiodon oregonensis* Leidy, *l. c.*
   Bridge Creek Beds, Oregon (Miocene).
2. *M.* †*distans* Marsh, American Journal of Science and Arts (3), Vol. XIV, pp. 250–251 (1877).
   John Day Beds, Oregon (Lower Miocene).
3. *M. senex* Marsh, *l. c.*, p. 250 (1877).
   John Day Beds, Oregon (Lower Miocene).
4. *M. elatus* Marsh, *l. c.*, pp. 250–251 (1877). Syn. *M. cooki* Barbour, Nebraska Geol. Survey, Vol. III, pt. 2 (1907).
   Lower Harrison Beds, Nebraska (Lower Miocene).
5. *M. petersoni* Holland, Science (New Series), Vol. XXVIII, p. 809 (1908). Syn. *M. parvus* Barbour, Nebraska Geol. Survey, Vol. III, pt. 3, p. 222 (1909).
   Lower Harrison Beds, Nebraska (Lower Miocene).
6. *M. matthewi* sp. nov. (*vide infra*).
   Pawnee Beds, Colorado (Middle Miocene).
7. *M. hollandi* Peterson, Science (New Series), Vol. XXXVIII, p. 673 (1913).
   Upper Harrison Beds, Nebraska (Middle Miocene).
8. *M. maximus* sp. nov. (?) *Vide infra.*
   Lower Harrison Beds, Nebraska (Lower Miocene).
9. *M. merriami* sp.nov. (?) *vide infra. Moropus* sp.? Merriam, Publ. Univ. California, Bull. Dept. Geol., Vol. VI, pp. 267–271 (1911).
   Virgin Valley Beds, California (Middle Miocene).

Genus Nestoritherium Kaup.

(Synonym *Ancylotherium* Gaudry.)

1. *N.* †*pentelicum* (Gaudry et Lartet), Comptes Rendus, Vol. XLIII, p. 271 (1856). = *N. pachygnathum* Kaup (1859) (*nec Rhinoceros pachygnathus* Wagner).
   Pikermi, Greece (Late Miocene).

Subfamily MACROTHERIINÆ.

Genus Macrotherium Lartet.

1. *M.* †*grande* (Lartet), Comptes Rendus, Vol. IV, pp. 85–93 (1837).
   Sansan, France (Miocene).

Synonyms: *M. sansaniense* Lartet, Notice sur la Colline de Sansan, p. 22 (1851); *M. magnum* Lartet, *l. c.*, p. 30 (1851); Filhol, Ann. Sc. Geol., XXI, p. 294 (1891); Osborn, American Naturalist, Vol. XXVII, p. 118 (1893); *M. giganteum* Gervais, Zoöl. et Paléont. Francaises, 1re Ed., p. 136 (1848), 2me Ed., p. 252 (1859); *var. secundarium* Filhol, Mam. Foss. de Sansan, Pl. XLV, fig. 2 (1889).

2. *M. rhodanicum* Depéret, "Mammifères Miocènes de la Grive-Saint-Alban, etc." Archives Mus. Lyon, Vol. V, p. 63 (1892).

Genus Chalicotherium Kaup.

1. *C.* †*goldfussi* Kaup, Descriptions d'Ossements Foss. de Mammif., etc., Cahier II, p. 6 (1883).

   Synonyms: "*Pangolin gigantesque*" Cuvier, Ossemens Fossiles, 3me Ed., Vol. V, p. 193, Pl. XVI, figs. 26 and 27 (1825); *C. giganteum* Depéret, "Mammifères Miocènes de la Grive-Saint-Alban," etc., Arch. Mus. Lyon, Vol. V, p. 81 (1892).

   Eppelsheim, Germany (Pliocene).

2. *C. antiquum* Kaup, *l. c.*, p. 7 (1833).
   Eppelsheim, Germany (Pliocene).

3. *C. minus* (Lartet). (*Anisodon minus*) Lartet, Notice sur la Colline de Sansan, (1851).

4. *C. baltavarense* Pethö, "Ueber d. Foss. Säugeth. Ueberreste von Baltavár," Jahrbuch d. K. Ungar. Geol. Anstalt, pp. 455–464 (1884) (Upper Miocene).

5. *C. sinense* Owen, Quart. Journ. Geol. Soc. of London, Vol. XXVI, p. 429, Pl. XXIX, figs. 7–10 (1870); Lydekker, Cat. Foss. Mamm., Vol. III, p. 165, fig. 21 (1886) (Pliocene(?) of China).

6. *C. sindiense* (Lydekker), Mem. Geol. Survey India, Palæontologia Indica, Vol. I, p. 64 (82); Pl. VIII, figs. 11–14 (1876), Do., Vol. IV, p. 50 (1886).

Genus Circotherium Holland & Peterson. (*Cf.* p. 211.)

1. *C. Sivalense* (Falconer & Cautley), Trans. Geol. Soc. London, V, p. 502 (1837). Fauna Ant. Sivalensis, VIII, Pl. 80 (1847); "Paleontological Memoirs of Hugh Falconer, A.M., M.D.," etc., Edited by Charles Murchison, Vol. I, p. 208 *et seq.*, Pl. XVII (1868).

   Upper Siwalik Beds, India (Late Miocene or Pliocene?).

Species *incertæ sedis.*

Chalicotherium bilobatum Cope, "The Vertebrate Fauna of the Swift Current River," II, American Naturalist, Vol. XXIII, pp. 151–155 (1889).

The specimen very probably does not represent a Chalicotheroid, as an examination of its dentition shows.

Sphenocœlus uintensis Osborn, Bulletin American Museum Natural History, Vol. VII, p. 98 (1895). (*Cf. supra* under *Sphenocœlus*, p. 215.)

CHAPTER IV. THE SPECIES OF THE GENUS MOROPUS.

Order UNGULATA Ray.

Suborder **PERISSODACTYLA** Owen.

Superfamily *CHALICOTHEROIDEA* Gill.

Family CHALICOTHERIIDÆ Gill.

Genus Moropus Marsh.

1. **M. oregonensis** (Leidy).

(*Lophiodon oregonensis*) "Contributions to the Extinct Vertebrate Fauna of the Western Territories," p. 219, Pl. II, Fig. 1 (1870).

Type: Fragment of maxillary containing two cheek-teeth (P^4 M^1) (see Fig. 5, 1–2).

Location of Type: Condon Collection (*fide* Leidy); Peabody Museum, Yale University, No. 10030. (Purchased from Dr. Condon by Professor Marsh.)

Geological Horizon: Bridge Creek Beds, John Day region, Oregon (Lower Miocene?).

The description and figure given by Leidy (*l. c.*) were decided by Mr. Peterson to represent the dentition of a Chalicotheroid referable to *Moropus*. Quite recently, as this paper was going to the press, through the kindness of Dr. R. S. Lull we have received for purposes of study and comparison a number of fragments preserved in the Peabody Museum. It was intensely gratifying to discover in this material the type of Leidy's *Lophiodon oregonensis*, and associated with this by Professor Marsh are two premolars and a molar which may well have pertained to the same individual as Leidy's type, judging from the similarity in size and wear, together with the coloration and general condition of the different fragments. The fragments pretty plainly show that they are surface fragments, and may have been picked up at the same spot by different parties at different times. A first and second upper molar also referred by number to the same specimen, belong, however, undoubtedly to a different individual, and are here designated by No. 10030*a*, in order to separate them from Leidy's type. Besides these specimens coming from the Yale Museum, we have received from the American Museum of Natural History a posterior upper molar from the John Day formation. This

specimen we have also figured. These teeth which are unmistakeably referable to *Moropus* give us all that is at present known of the dentition of the Chalicotheres of the John Day formation (see Fig. 5).

In general proportion and details of structure P^3 and ^{4} of *M. oregonensis* do not present any important differences from those of *M. elatus*, except the slightly more brachyodont crowns and a less development of the parastyle. The molars which are provisionally referred to *M. oregonensis* are also more brachyodont than in *M. elatus*, and the parastyles less prominent, especially on M^1 and M^2 (see Fig. 5: 2, 5, 6, 7 and 8). M^3 appears to be proportionally broader and shorter than in *M. elatus*, but otherwise there is little or no difference in the detailed structure of the teeth.

Whether the teeth which are recognizable as belonging to the animal described as *oregonensis* by Leidy may ultimately be found to belong to one or the other of the animals described by Marsh as *M. distans* and *M. senex*, is a question which

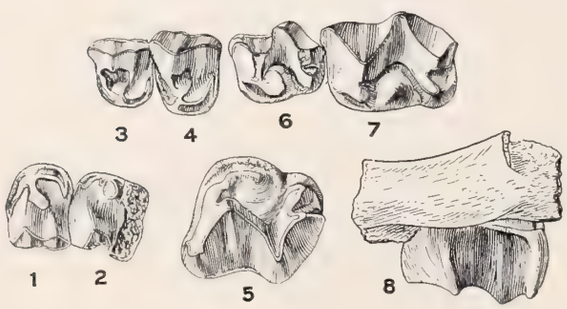


FIG. 5. *M. oregonensis* Leidy. 1–2, P^4 and M^1 of right side (type specimen described by Prof. Leidy; 3–4, P^3 and P^4 of left side; 5, M^3 of right side (3, 4, 5 probably belong with Leidy's type); 6–7, M^1 and M^2) (No. 10030*a*, Peabody Museum); 8, M^3, external view of No. 7259, A. M. N. H., and a portion of the malar bone, showing the inferior border of the orbit.

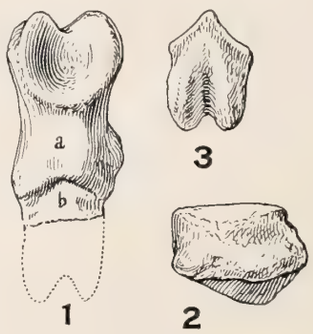


FIG. 6. The type of *M. distans* Marsh. 1, duplex bone, *a*, first phalanx, coössified with *b*, the second phalanx; 2, cuboid; 3, second phalanx. ×½. Drawn from Marsh's type. The bone represented by 1 probably belonged to digit III of the manus.

the future alone can decide. Marsh's material from the John Day consisted simply of fragmentary bones of the feet, generically, but not specifically, recognizable. It may well be that the event will prove the identity of *M. oregonensis* (Leidy), with either or both of the two so-called species of Marsh. Judging from the dentition, *M. oregonensis* was a smaller animal than *M. elatus* of Nebraska.

The bones recently described by Merriam (Bull. Dept. Geol. Univ. Calif., Vol. VI, pt. ii, pp. 267–271 (1911)), without giving them a specific name, but for which we suggest the name *M. merriami*, coming from the Virgin Valley Beds,

evidently represent an animal of considerably larger size than *M. oregonensis*, an animal in fact quite equal in size to *M. elatus*, if not surpassing it. These remains come from a later geological horizon than those originally described by Leidy and by Marsh, the Virgin Valley Beds belonging according to Merriam to the Middle Miocene.

2. **M. †distans** MARSH, American Journal of Science and Arts (3), Vol. XIV, p. 249–250 (Sept. 1877).—Peterson, "Preliminary Notes on Some American Chalicotheres," American Naturalist, XLI, pp. 733–752 (1907).

Type: Coössified first and second phalanx, median phalanx, and cuboid (the latter identified as such by Peterson, *l. c.*). (*Cf.* Fig. 6, p. 220.)

Location of Types: Peabody Museum, Yale University.

Geological Horizon: John Day Beds, Oregon (Lower Miocene).

"*Moropus distans*, gen. et sp. nov.

"This genus of Edentates is based mainly upon the bones of the feet, which have been found in several individuals. These remains are quite different from the feet bones of any of the American Edentates, recent or fossil; but indicate affinities with the extinct *Ancylotherium*, from the Tertiary of Europe, which is supposed to be related to the American Ant-bear (*Orycteropus*). The specimens here described belong to a distinct family, the *Moropodidæ*.

"In the type specimen of the present species, only the hind feet appear to be represented. One of the most characteristic bones is a coössified first and second phalanx. The articulation for the metatarsal is nearly in a horizontal plane, and situated on the proximal end of the upper surface of the base. It is somewhat heart-shaped in outline with the apex rounded and about equally concave in both directions, or slightly less so transversely. This articulation occupies nearly half the length of the first phalanx which is thoroughly coössified with the second. The line of junction between the bones can, however, be traced easily, and is strongly marked on the under surface by a pit or foramen entering obliquely upwards and forwards. Except near this line of junction, the surface of the bone is rather smooth. The under surface, below the articulation, is flattened. The second phalanx is less than half the length of the first, and its surface is roughened, as if by abnormal growth of bone over the surface. The length of the first phalanx is 43 mm.; the longitudinal diameter of the matacarpal articulation 18 mm.; its transverse diameter 23 mm. The least transverse diameter of the bone is 21 mm.; its vertical diameter at the middle is 20 mm. The second phalanx is broken in this specimen, its distal articular face being absent.

"Associated with the above specimen is a short bone evidently a median phalanx, with both articular surfaces well preserved and in form corresponding to each other. Proximally there are two grooves separated by an intermediate ridge, and distally two pulley-shaped ridges with a deep groove between. The length of the shaft of this bone is 23 mm.; its transverse diameter is 21 mm. proximally, and 17 mm. distally. Near the center of the terminal pulleys is a deep pit on each side. The greatest vertical diameter of the bone is 32 mm. This bone resembles the penultimate phalanx of the middle finger of *Priodontes*, but is some what shorter and thinner.

FIG. 7. The type of *M. senex* Marsh. Duplex bone. ×½. Probably belonging to digit II of manus.

"These and other less characteristic remains indicate an animal somewhat larger than a tapir. They were found in the Miocene of Oregon by the Yale Expedition of 1873" (*Original Description of Marsh, l. c.*).

3. **M. senex** MARSH, American Journal of Science and Arts (3), Vol. XIV, p. 250 (Sept. 1877).—Peterson, American Naturalist, Vol. XLI, pp. 733–752 (1907).

Type: Coössified first and second phalanx. (*Cf.* Fig. 7.)
Location of Type: Peabody Museum, Yale University.
Geological Horizon: John Day Beds, Oregon (Lower Miocene).

"*Moropus senex*, sp. nov.

"A second larger species of the same genus is indicated by a few remains, among which is the characteristic bone formed of the united phalanges. The proximal phalanx is considerably larger than the one above described. Its length is 52 mm. The proximal articulation is oblique, and does not occupy more than one-third the upper surface of the bone. The median phalanx is well preserved, and measures 25 mm. in length. It is not united with the first phalanx in a line with the axis of that bone, but is inclined about 15° toward the sole of the foot. Its distal articulation is composed of two not very prominent pulley-shaped surfaces with a groove between" (*Original Description by Marsh*).

4. **Moropus elatus** MARSH, American Journal of Science and Arts (3), Vol. XIV, pp. 250–251 (1877).—Scott & Osborn, Bulletin Museum of Comparative Zoölogy, Vol. XX, p. 99 (1890).—Zittel, Handbuch d. Palæontologie, Bd. IV, pp. 314–315 (1893).—Peterson, Annals Carnegie Museum, Vol. V, p. 60 (1906). —*Idem.*, "Preliminary Notes upon Some American Chalicotheres," American

Naturalist, Vol. XLI, pp. 733–752 (1907).—Holland, Science (New Series), Vol. XXVIII, p. 809 (1908).—Osborn, Bulletin American Museum Natural History, Vol. XXXII, p. 263 (1913).

Synonym: *Moropus cooki* Barbour, Nebraska Geol. Survey, Vol. III, pt. 2, p. i (1908).

Type: A number of the bones of the feet and a patella.[10]

Neotype: Articulated skeleton and great assemblage of other material.

Location of Types: Peabody Museum, Yale University.

Location of Neotype: Carnegie Museum, Pittsburgh.

Geological Horizon: Lower Harrison Beds, Nebraska (Lower Miocene).

Specific Characters: Supraorbital ridges nearly meeting to form a low sagittal crest; interparietal subtriangular in outline; cervical vertebræ massive; transverse

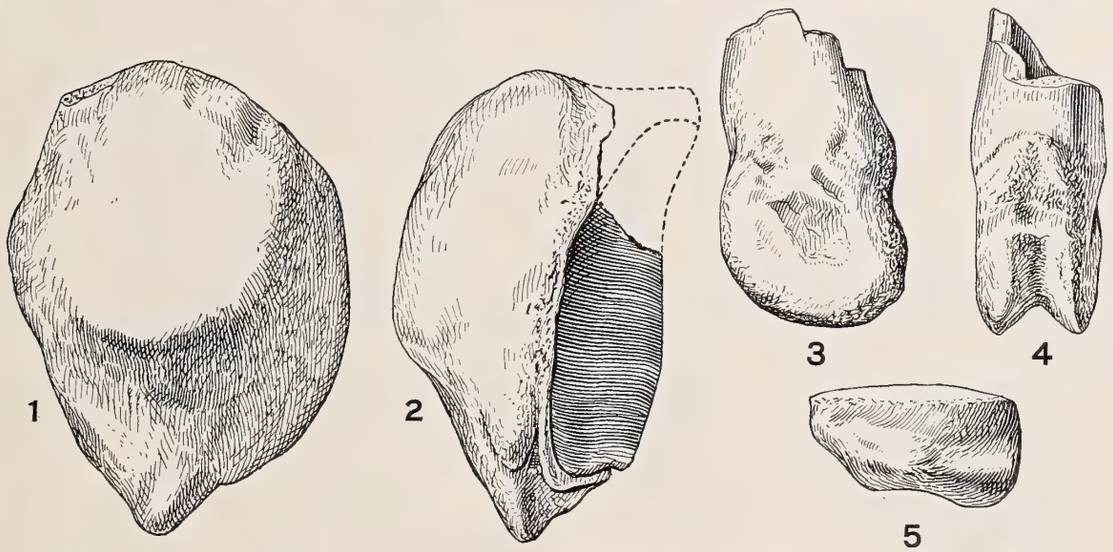


FIG. 8. Part of type of *M. elatus* Marsh. 1–2, patella; 3–4, lateral and dorsal views of duplex bone; 5, cuneiform of right forefoot. ×½. Drawn from Marsh's types.

process of the fifteenth dorsal having a great vertical diameter, and pierced by a foramen; anterior lumbar vertebræ assuming the lumbar form somewhat abruptly, and not retaining the features of the antecedent dorsals; neural spines of the lumbars and sacrals sloping but little backward; limbs and feet relatively heavy; fore and hind limbs subequal in length; scapula broad and comparatively short; facets for trapezium on scaphoid and on metacarpal II well indicated; metapodials relatively long and not expanding rapidly at their distal extremities; animal as large or larger than an African rhinoceros.

[10] In 1906 Peterson placed the genus and species upon a firm basis by a comparative study of the types in the Peabody Museum and the collections acquired by the Carnegie Museum.

The species, remains of which have been recovered in most perfect condition in the Agate Spring Quarry, has been identified both by the writer and his colleague, Mr. Peterson, as *Moropus elatus* Marsh. The types preserved in the collection of Professor Marsh in the Yale Museum are fragmentary, but they absolutely agree in every respect with the corresponding portions of the animal remains of which were found in Carnegie Hill. If type specimens have any value whatever in enabling the determination of a species, then it is true that the remains above alluded to, which were recovered during the seasons of 1904 to 1908, belonged to the animal named *Moropus elatus* by Marsh.

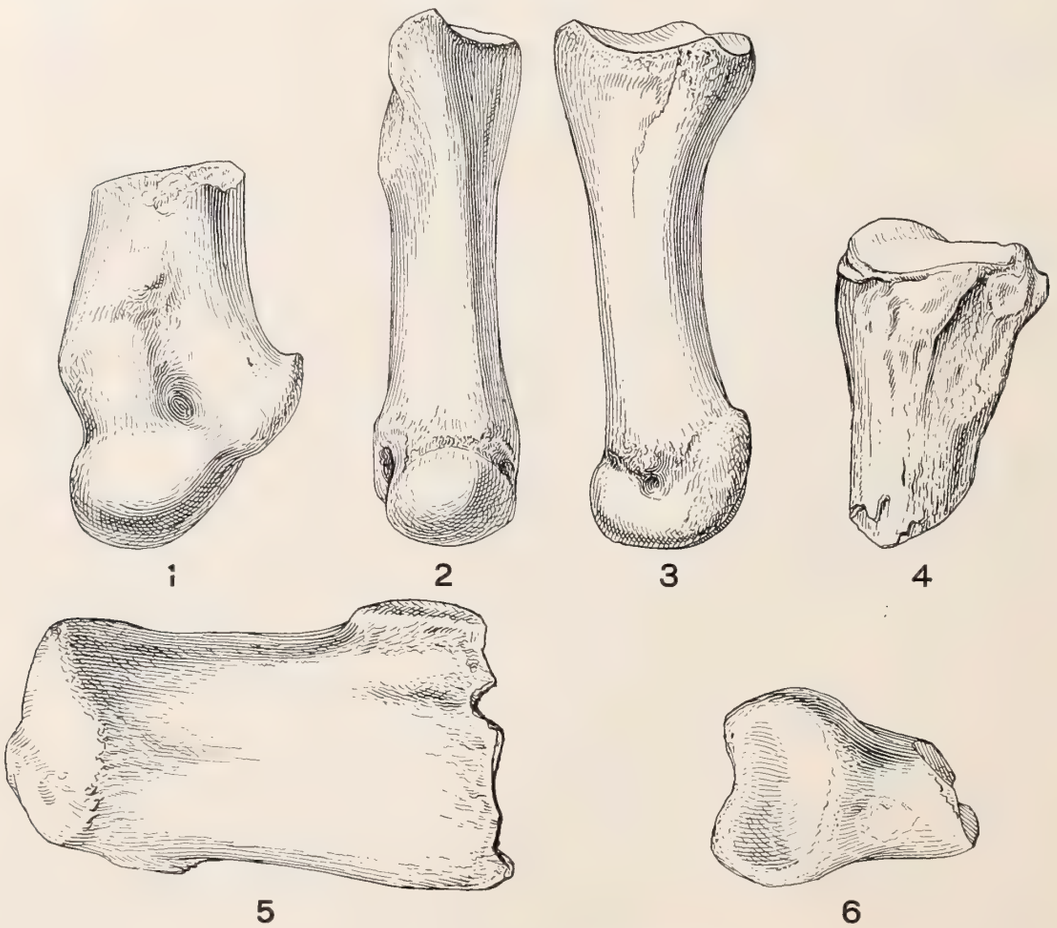


Fig. 9. Part of the type of *M. elatus* Marsh. 1, distal end of Mc. II; 2–3, dorsal and tibial views of Mt. II; 4, radial face of Mt. III; 5, fibular view of calcaneum; 6, dorsal view of a first phalanx. ×½. Drawn from Marsh's types.

In October, 1908, the writer received from Professor Erwin H. Barbour a copy of an account of the fragmentary cranium of *Moropus* which he recovered in

the summer of 1905 in his opening on University Hill. For this specimen he has proposed a new specific name, calling it *Moropus cooki* in honor of Mr. James H. Cook. Professor Barbour says: "Marsh's *Moropus elatus* was found at Fort Niobrara, Nebraska, hence in supposed Upper Miocene, while the one presented here was found at Agate, Nebraska, in supposed Lower Miocene. The difference in geologic horizon seems sufficient to warrant belief in difference of species." In what way Professor Barbour derived the impression that the types of Professor Marsh came from Fort Niobrara and from a higher geological horizon he is unable to explain, as he has frankly stated to the writer in private correspondence. Mr. Peterson having positively expressed the opinion that Professor Barbour was mistaken in this matter, the writer took steps first of all to ascertain through Professor R. S. Lull when and where the types of *Moropus elatus* were collected. In the first reply received from Dr. Lull he stated that all that he could report was the fact that the specimens had been collected by Mr. H. C. (Hank) Clifford in the spring of 1875 and forwarded to New Haven from "White River Station." Diligent search of gazetteers, maps, reports of United States Indian commissioners and agents, and the records of the United States Department of the Interior, so far as accessible, failed to show the existence of a "White River Station" in Nebraska unless under this name were intended the military post on the White River in the vicinity of Crawford, Nebraska, now Fort Robinson. The writer then took steps to ascertain whether Mr. H. C. Clifford might still survive and be able to give any information in regard to the matter. The result of inquiries directed to the commandant at the Red Cloud Indian agency was the discovery that the death of Mr. Clifford had taken place in 1905. Just after getting this information the writer was pleased to receive from Professor Lull a letter under date of November 6, 1908, in which he says:

"*Dear Doctor Holland:* I have found Clifford's correspondence and bill of lading of the lot of material sent in with the *Moropus* type.

"On March 13, 1875, Mr. Clifford was at Crow Buttes, eight miles east of Red Cloud agency, from which he sent a letter announcing his intended departure 'in a few days' for Sydney, Nebraska, with two wagon-loads of bone. The shipment was made from Sydney on the U. P. R. R. (not White River), the bill of lading bearing the date of April 2, 1875. As the *Moropus* specimen was collected March 21st or 24th[11] it must have been *en route* from Crow Buttes to Sydney, presumably where the trail crossed the Niobrara River.

The Red Cloud agency is indicated on Rand & McNally's map of *South Dakota*, dated 1890,

[11] The field-label in Mr. Clifford's handwriting bears date of March 24, the label written in Professor Marsh's handwriting gives March 21 as the date. Professor Marsh's date may well have been a *lapsus calami*, and the slight discrepancy does not possess any importance.

just north of the White River, Nebraska, and east of Andrews, our point of shipment this summer. I do not know just how the trail would run, possibly Mr. Peterson does, but it would seem to cross the Niobrara not far from the Agate Spring Quarries if one may judge from the map.

"While Clifford's collection had been made before leaving Crow Buttes, it was not boxed until he reached Sydney, so that any material picked up *en route* could readily have been added.

"All this evidence seems to be in accordance with Peterson's belief as to the probable locality of the type of *Moropus*. I should however like to learn your judgment in the matter."

Inquiry has developed the fact beyond doubt that the military road between the Red Cloud Agency and Sydney, over which in 1875 travel between the Union Pacific Railroad and the Fort on the White River took place, crossed the Niobrara River on the property locally known as "Lower 33," this being the name of a horse-ranch. The point where the crossing was made, is, as I am informed by those who are familiar with the country, east of the ranch now owned by Mr. Octave Harris, and therefore between four and five miles east of the Agate Spring Quarries. Exposures of the lower Harrison beds containing fossils occur all along the Niobrara River for a considerable distance eastward from the point where the collections of the Carnegie Museum have been made, possibly for twenty miles, though the exact eastern limits of the outcrop of these beds have not as yet been definitely ascertained. It is thus definitely ascertained that the types of Professor Marsh were collected by Mr. Clifford at the time he was in the neighborhood of the crossing of the Niobrara River while on his way from the Red Cloud agency to Sydney. They may possibly have been picked up by him at the identical spot where the work done by the Carnegie Museum has been carried on; or they may have been surface fragments coming from the same beds which he found at some point east of the locality which was explored by Mr. Peterson and his associates. Without any further evidence than that which we possess it is of course impossible to locate the exact spot at which the remains were recovered, but that they came from the Lower Harrison beds on the Niobrara River is in the opinion of the writer established beyond the shadow of a doubt. In view of this fact, inasmuch as there is absolute agreement between the skull collected by Professor Barbour and the skull in the possession of the Carnegie Museum so far as dentition and all other important points, even that of size, are concerned, the writer is compelled, though reluctantly, to regard the name *Moropus cooki*, which Professor Barbour has proposed for the specimen, as a synonym for *Moropus elatus* Marsh.

5. **Moropus petersoni** Holland, Science (New Series), Vol. XXVIII, p. 810 (Dec. 6, 1908).

Synonym: *M. parvus* Barbour, Nebraska Geol. Survey, Vol. III, pt. 3, p. 222 (1909).

Type: Portions of skulls, a series of cervical vertebræ, a series of anterior and posterior dorsals and lumbars, fore limb and manus, hind limb and pes, representing different individuals, and bearing the following numbers in the Catalog of Vertebrate Fossils in the Carnegie Museum: No. 1707, 1703*A*, *B*, and *C*, 1700, and 1701.

Paratype: Upper posterior portion of a cranium belonging to Mr. Harold Cook's Collection, No. 133.

There is a considerable quantity of other fragmentary remains of this species, besides those upon which the original description was based, which are contained in the Carnegie Museum.

Geological Horizon: Lower Harrison Beds, Nebraska (Lower Miocene).

Specific Characters: Supra-orbital ridges well separated revealing a broad smooth area between them, and not tending to unite to form a sagittal crest near the occiput; interparietal subquadrate in outline; cervical vertebræ relatively light; transverse process of fifteenth dorsal simple, not pierced by a foramen; the transition between the posterior dorsals and anterior lumbars marked by a less abrupt change in the form of the zygapophyses of the latter than is the case in *M. elatus;* neural spines of the lumbars and sacrals having a comparatively greater backward slope than in *M. elatus;* limbs and feet relatively light; scapula narrow and long; size approximately that of a tapir.

The material secured in the openings made in Carnegie Hill representing the genus *Moropus* consists of the remains of a number of individuals of large size, which it is possible in the light of Professor Marsh's types to unhesitatingly refer to *Moropus elatus* Marsh, as has already been pointed out. Associated with this material there are remains, some of which undoubtedly represent smaller and less mature individuals of the same species. There is also a quantity of material, some of it representing undoubtedly immature individuals, but a great deal of it representing fully adult individuals, which differs widely in many particulars from that representing *M. elatus.*

Three hypotheses have been proposed and discussed in all their bearings: (1) that this material may represent immature specimens of *M. elatus;* (2) that it may represent the female sex of *M. elatus;* (3) that it may represent a species different from *M. elatus.*

1. *First Hypothesis.*—In favor of this hypothesis is the fact that the specimens are smaller in size and that a few of them through the loss of the epiphyses of the

centra of the vertebræ, and by the disarticulation which is shown in some of the parts, were immature.

Against this hypothesis is the fact that a large proportion of this material represents animals which were undoubtedly fully adult, as is shown by the condition of the bones. We have in fact material representing both the juvenile and the fully adult stage of animals which in many of their proportions show that they were not much more than half the size of the adult *M. elatus*, as represented in the articulated skeleton, approximating in size a large tapir, while *M. elatus* in its fully adult form was as large as a rhinoceros.

Against this hypothesis is the fact that these bones agree in presenting important differences in the form of the last dorsal vertebræ, the prezygapophyses of the dorsals and first lumbar, the slope of the neural spines of the sacrum, the development of the limbs, including the scapula, and the contour of the upper part of the cranium. In the original description of *M. petersoni* the writer called attention to the fact that the interparietal in the latter species is subquadrate in outline, while in *M. elatus* it is triangular in all stages of development. This distinction appears to hold good in the adults and the young of the two forms. In our material we have the skull of an adolescent individual of *M. elatus* (No. 2104) in which the temporal ridges come together to form a low sagittal crest as completely as in the fully adult specimen (No. 2103) and revealing the interparietal bone as having the outline of a narrow isosceles triangle, just as in the latter specimen. This specimen shows that the peculiar configuration of the posterior upper surface of the skull is as characteristic in young specimens of *M. elatus*, as it is in old specimens. In view, therefore, of the fact, that, in predicating the specific identity of the material under discussion with that representing *M. elatus*, we would have to rest simply upon its smaller size, disregarding a number of other obvious differences, the writer, after careful consideration, has been led to reject the first hypothesis as untenable.

2. *Second Hypothesis.*—The second hypothesis which may be applied to this material is, as has been pointed out, that it represents the female sex, while the material representing the larger animal represents the male sex.

In favor of the view that this hypothesis may be correct, it can be urged, *first*, that among mammals the female is generally of smaller size than the male; *secondly*, that the limbs and feet in the female are slenderer and not as heavily built as in the male; *thirdly*, that in the skull there is often a tendency to the development of a sagittal crest or other prominences in the male, while such features are absent, or less marked, in the female. Allowing full weight to these considerations, it

would be true that associated with them in the case of the female there should also be found an increase in the pelvic dimensions and provision for a fuller nutrition in the pelvic region.

An attentive study of the material before us shows that the last two requirements are not met. There are two very well preserved ossa innominata of the smaller form in which the relative proportions of the bones show that the pelvis, so far as its posterior opening is concerned, was relatively smaller in size than is the case in the large specimen (No. 1604) which has been selected for restoration as a mounted specimen and identified as *M. elatus*. This specimen consists of the *os innominatum* used in the restoration of the hind limb of *M. petersoni*, and numbered 1701 in the Catalog of Vertebrate Fossils in the Carnegie Museum, and specimen No. 1705.[12] This indicates that these remains were those of a male rather than of a female. Strangely enough there is another specimen of the smaller form, consisting of the *ossa innominata* (No. 1705) in which the dimensions do show an enlargement, which might allow this part of the skeleton to be regarded as that of a female.

Furthermore, the vascular system of the pelvis, so far as any opinion can be formed in relation to it, from the size of the foramina of the posterior dorsals, lumbars, and sacrals, was not more abundantly nourished in the smaller form than in the larger, if indeed as well nourished. The foramina giving exit to the nerves and entrance to the arteries are proportionately larger in the larger form than they are in the smaller. The writer is of the opinion that the pelvic bones do not show, except in the one instance cited above, as that of a female pertaining to the smaller form, that relative increase in the size in proportion to the other parts which would imply that the specimens before him were those of female animals. In other words, the best preserved pelvis of the smaller creature which we possess is in its dimensions proportionately smaller than in the larger animal, but in one specimen belonging to the smaller animal we have remains which would indicate that we are dealing with the pelvis of a female of the same form. Furthermore the very great difference in size, a difference, which it has already been pointed out, is as great as that between a large rhinoceros and a tapir, seems to be too great to be regarded as a merely sexual character.

The second hypothesis is therefore rejected, and the writer adopts the *third hypothesis*, namely, that we are dealing in the case of this material with a species represented by more or less complete specimens of the skull, the vertebræ, the

[19] In Science, N. S., Vol. XXVIII, p. 810, the numbers 1700 and 1701 were unfortunately reversed. No. 1701 applies to the hind limb and 1700 to the fore limb.

limbs and pelves of both male and female individuals. To this species the writer has applied the name of *M. petersoni.* It is apparently the same animal to which Professor Barbour (*l. c.*) applied the specific name *parvus.*

6. **M.** (?) **maximus** sp. nov. (?).

In Quarry No. 2 Mr. W. H. Utterback recovered with other material a very large scapula. The scapula is designated in our Catalog as No. 1776. It greatly exceeds in size the scapulæ of fully adult specimens of *M. elatus;* the posterior border is sharply angulated above the middle, and not rounded as in *M. elatus* and *M. petersoni;* and the tuberosity of the spine is most broadly developed at its lower extremity, whereas in the two last mentioned species, this tuberosity is enlarged about the middle of the spine, presenting a wholly different facies, as may be seen by comparing the figure (see Fig. 77) with that of the scapula of *M. elatus* on Plate LXV. In view of its great size, and the features to which we have just called attention, we are led to think that we are dealing in the case of this bone with an animal which must be regarded as at least specifically, if not generically, distinct from the others which have been studied. We hesitate to found a species, much less a genus, on a single bone, but nevertheless we have caused this specimen to be figured (see Fig. 77), showing its peculiarities, which may assist future students in identifying similar material should it be recovered. It has been suggested that this large scapula does not represent a new species, but belonged to a very old male in which an enormous development of surfaces for muscular attachment had taken place, though most writers would, we think, be inclined to the opinion that the theory of a specific difference should hold good. Should later discoveries prove the truth of the latter view, the species may be designated as *Moropus maximus.* It is, moreover, possible that this scapula does not represent *Moropus* at all, but some animal more nearly related to the Titanotheres. The entire absence, however, of all other material representing the latter family in these beds gives much occasion for doubting such a reference. It would be indeed singular that among the thousands of bones gathered from these beds the only representative of a Titanothere should be a shoulder blade, and that it should occur so high above the Oligocene.

7. **Moropus matthewi**[13] sp. nov.

Type: Various foot bones and an upper molar tooth, Nos. 9076–8, 9080, 9368, Collection of the American Museum of Natural History, New York.

Geological Horizon: From near Pawnee Buttes, Northeastern Colorado (Pawnee Creek Beds, Middle Miocene).

[13] The specific name is applied in honor of Dr. W. D. Matthew, of the American Museum of Natural History, who discovered the type.

The type specimens (see Fig. 10), though fragmentary, plainly reveal an animal the metapodials of which are shorter, heavier, and more suddenly enlarged

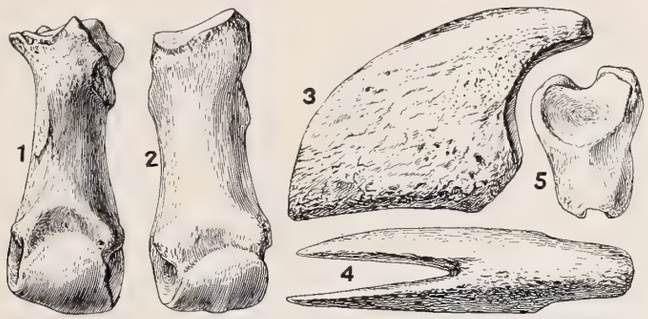


FIG. 10. *M. matthewi* sp. nov. 1, anterior view of Mt. II of right side (A. M. N. H., No. 9368); 2, ant. view of Mt. III of left side (A. M. N. H., No. 9077); 3, lateral view of ungual of digit II of manus (A. M. N. H., No. 9076); 4, superior view of do.; 5, superior view of proximal phalanx of manus (A. M. N. H., No. 9080). All figures $\frac{1}{3}$ nat. size.

distally than is the case in the species of *Moropus* found in the Lower Harrison Beds of Nebraska. The terminal phalanx of digit II of the manus is quite high and is compressed laterally to a slightly greater degree than is the case in specimens of *M. elatus*. The molar tooth of the type specimen is much worn and furnishes no characters of specific value.

It is possible that the remains from the Virgin Valley, California, described by Dr. Merriam,[14] pertain to this species. The material before us, however, represents an animal of smaller size. The description and the figure (Fig. 45*a*) of the ungual phalanx given in Dr. Merriam's paper seems, except in size, to agree in every detail with the corresponding ungual of *M. matthewi*. From Dr. Merriam's illustrations it is quite clear that the specimen from Virgin Valley has a broader and lower astragalus and a shorter tuber on the calcaneum than *Moropus elatus*.

MEASUREMENTS.

	Mm.
Upper molar, antero-posterior diameter	50
Upper molar, transverse diameter	36
Metatarsal II, greatest length	124
Metatarsal II, transverse diameter of head	45
Metatarsal II, transverse diameter middle of shaft	31
Metatarsal II, transverse diameter distal end	48
Ungual phalanx of Digit II, manus, greatest length	147
Ungual phalanx of Digit II, manus, greatest height	87
Ungual phalanx of Digit II, manus, greatest transverse diameter	37

[14] "Tertiary Mammal Beds of Virgin Valley and Thousand Creek in Northwestern Nevada," Publ. Univ. California, Bull. Geol., Vol. VI, pp. 267–271 (1911).

8. **M. hollandi** PETERSON, Science (New Series), Vol. XXXVIII, p. 673 (1913).

Type: Radius, ulna, and portion of fore foot, femur, tibia, fragment of fibula, and portions of both hind feet.[15] (No. 1424 Catalog Vert. Foss. Carnegie Museum.)

Specific Characters: Limbs slenderer than in *M. elatus* or *M. petersoni*. Third trochanter of femur less developed than in the latter species. Facet for the trapezium on the scaphoid much reduced or wanting. Facet for trapezium on trapezoid not extending down to the lower face of the trapezoid as in *M. elatus* and *M. petersoni;* the heavy protuberance on the dorso-radial angle of the trapezoid (found in *elatus* and *petersoni*) absent. Facet for trapezium on Mc. II wanting. Metacarpals proportionally long and slender. Proximal and medial phalanges of second digit of manus more compressed laterally than in *M. elatus* or *M. petersoni*. Animals larger than a tapir, but smaller than *M. elatus*.

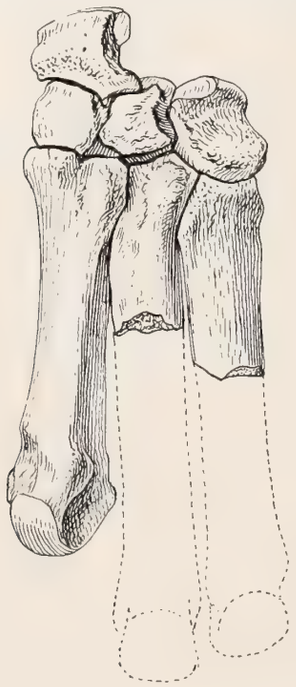


FIG. 11. Anterior view of left manus of *M. hollandi* Peterson. $\times\frac{1}{3}$.

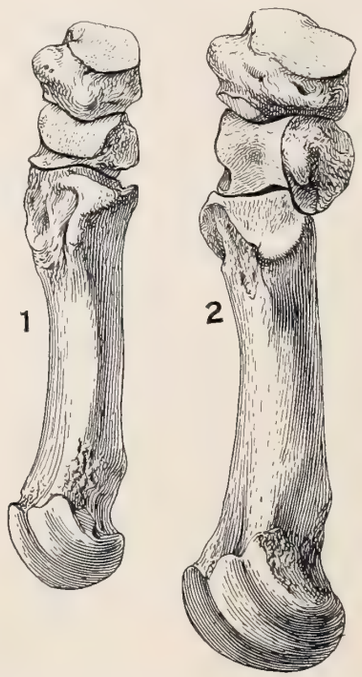


FIG. 12. Postero-radial view of scaphoid, trapezoid and Mc. II of *M. hollandi* (1) compared with the same bones of *M. elatus* (2). $\times\frac{1}{3}$.

Geological Horizon: Upper Harrison Beds, Western Nebraska near Wyoming State-line (Middle Miocene).

The olecranon process of the ulna is short and heavy, as in the Chalicotheres generally. Distally the radius and ulna are rather slender and very much elongated.

[15] This material was discovered in 1901 and partially described by O. A. Peterson (Ann. Car. Mus., Vol. IV, pp. 60–61, 1906) under *M. elatus*. The description here given amplifies the original.

The general shape of the carpus is similar to that in *Macrotherium*, but is not nearly so heavy. On the ulnar side of the scaphoid, at the distal end, is a heavy and rounded process, which reaches over in the ulnar direction and articulates with the superior face of the magnum as in *Macrotherium*.

The articulation for the scaphoid on the magnum is, however, more lateral in *Macrotherium* than in the species under consideration. The unciform has a heavy projection on the dorso-radial angle, which extends upward and radially over the ulnar border of the magnum. This character of the unciform is quite like what is found in the European form from Pikermi, but not like what is seen in *Macrotherium* from Sansan, according to the illustrations which have been given.[16]

Some of the distinguishing characters of the fore foot of this species are: the much reduced facet for the trapezium on the scaphoid and *Mc. II* (see Fig. 12, 1), which may even be absent; the great downward deflection of the facet for the scaphoid on the radial face of the bone, plainly indicating the presence of a trapezium, though its articular surface does not extend to the margin of the articulation for *Mc. II* as in *M. elatus* and *M. petersoni*, and was therefore undoubtedly reduced in size, and did not touch *Mc. II*, as in the latter species. The trapezoid has not the heavy protuberance on the dorso-radial angle seen in *M. elatus* and *M. petersoni* (see Figs. 11 and 12), and the articular face for the trapezium does not extend down to the articulation for *Mc. II* as in these species. *Mc. II* is proportionally longer and slenderer than in *M. elatus* or *M. petersoni*. Upon more accurate measurements and comparison with the cast of *Mc. II* of *Macrotherium grande* of Sansan this bone in the present species is seen to be longer and slenderer, though Peterson stated in the original description (*l. c.*) that *Mc. II* in the two specimens were of nearly the same length. The distal ends of *Mc. III* and *IV* are unfortunately broken off and their length cannot be ascertained from the type. *Mc. V* was present, as is plainly indicated by a facet on the ulnar face of *Mc. IV*. The coössified first and second phalanges of the second digit of the manus are present and show plainly a comparatively greater lateral compression than is shown by the duplex bone in either *M. elatus* or *M. petersoni* (see Fig. 13).

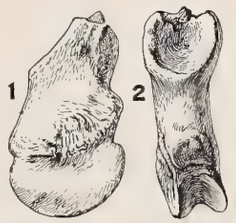


FIG. 13. Coössified proximal and median phalanges of left digit II of manus of *M. hollandi* (No. 1424). ×⅓. 1, lateral view; 2, dorsal view.

The head of the femur rests on a very short neck and the great trochanter

[16] Since the original description in the Annals (*l. c.*) was published the Carnegie Museum has obtained casts of these various European types. The unciform of *Macrotherium* is not represented and apparently is not known, but was supplied in the published illustration, referred to.

apparently does not extend above the head. There is a broad and rugose third trochanter on the femur, a character which is wanting in some of the European genera, *e. g.*, *Macrotherium*. The third trochanter is relatively less developed than in *M. elatus* or *M. petersoni*. The lesser trochanter is also quite prominent. The condyles of the femur are broken. The tibia, which is short and heavy, has a prominent spine, which separates the broad articular facets for the distal end of the femur; the cnemial crest is well developed. The fibula, though small, has a complete shaft.

MEASUREMENTS.

	Mm.
Greatest length of radius and ulna	600
Vertical diameter of scaphoid	40
Vertical diameter of trapezoid	30
Length of Mc. II	170
Transverse diameter of carpus at the head of the metacarapls	96
Length of femur, approximately	500
Length of tibia, approximately	385
Greatest length of calcaneum	113
Transverse diameter of tuberosity of calcaneum near the free end	35
Vertical diameter of astragalus	64
Greatest transverse diameter of astragalus	82

9. **M. merriami** sp. nov.

Moropus sp.? Merriam, Publ. Univ. California, Bull. Dept. Geol., Vol. VI, pp. 267–271 (1911).

The remains described and figured by Professor Merriam from the Virgin Valley Beds of Oregon, not only appear to be from a later geological horizon than the forms described by Leidy and Marsh from the John Day formations, but they represent an animal of much greater size than *oregonensis*, *distans*, and *senex*, judging from the material brought to our knowledge. It seems highly probable that in this case we are dealing with a form, which is specifically distinct from the others found in Oregon. Should subsequent researches justify this opinion, we propose for the animal, the remains of which have been well described and figured by Professor Merriam, and which may therefore be regarded as the types, the name above given, in recognition of the labors of this distinguished paleontologist.

CHAPTER V. THE OSTEOLOGY OF MOROPUS.

The Head.

(Plates XLVIII–LIII.)

The Cranium.—While an abundance of material representing the limbs and feet of *Moropus* has been recovered, and the supply of vertebræ obtained from the quarries opened by the Carnegie Museum is not inconsiderable, crania in an absolutely perfect condition have not been found. The nearest approach to a perfect specimen is the fine cranium belonging to the mounted specimen of *Moropus elatus*, which was obtained by Mr. Peterson in the quarry on the west side of Carnegie Hill in the month of September, 1908, and which is catalogued as No. 2103. The premaxillaries in this specimen are missing, and the top of the cranium, while preserving its contour, has been crushed downward upon the teeth. The line of weakness along which the crushing has taken place extends horizontally from a point near the posterior end of the zygomatic arch forward to the point of union of the premaxillaries with the maxillaries. A disarticulated and somewhat fragmentary cranium of an immature specimen of *M. elatus* was recovered in 1908 and catalogued as No. 2104. A smaller specimen, representing *Moropus petersoni* Holland, was found in a more or less disarticulated condition and has been skillfully restored by Mr. Peterson, enabling a comparative study of this cranium to be made. In addition to these two specimens a number of other portions of crania in a more or less fragmentary condition have been recovered. The specimens consist of fragments of the maxillaries with the teeth, in several cases quite well preserved, and dislocated parts of the occipital region. Prof. E. H. Barbour, as has been previously stated, secured the lower portion of a cranium of *Moropus elatus* with the premolar-molar series of teeth lacking the first premolar in a good state of preservation on both sides. Upon this he based a brief article published in the Reports of the Geological Survey of Nebraska, Vol. III, No. 2. The chief value of this specimen is derived from the fact that it enables a very thorough study of the palatal region of the skull to be made from above as well as below, in this respect offering some advantages which are not to be derived from the more complete specimen obtained by Mr. Peterson. Professor Barbour has given us an outline drawing of this specimen as well as some reproductions of photographs, which are not quite as distinct as might be desired. Through the kindness of Mr. Harold Cook, the writer has been allowed to study and describe the posterior portion of the upper surface of a cranium found by Mr. Cook, which belongs to *Moropus petersoni*. This is shown in Fig. 14.

While crania, owing to their fragile nature, have not been recovered in considerable numbers, mandibles were not uncommon in the quarries. The mandible of the mounted specimen No. 1604 was recovered in almost perfect condition, having only suffered slight distortion in the region of the symphysis, and in addition ten pairs of lower jaws in a more or less complete state of preservation and numerous single jaws, preserving the lower dentition in perfect order, were found. There is therefore no lack of material upon which to form an idea of the form of the lower jaw and of the accompanying dentition.

As has been stated, the skull belonging to the restored skeleton was crushed downward. Before mounting the specimen the senior author resolved to effect a restoration. Careful measurements of the exposed anterior margins of the ascending plate of the maxillary and the contiguous bones when they had been crushed down and buckled over each other permitted us to ascertain with approximate certainty the height of the nasals above the line of the teeth, and similar measurements made with great care enabled us to determine the distance of the occipital crest above the basi-sphenoid. Having determined in this manner the outline of the skull we set to work to make a restoration, the figure of which is given in Plate LIII. This restoration is believed to be approximately accurate, and represents the general outline as it existed in an uncrushed state.

The occipital condyles are trihedral in form with the outer surface above and below strongly convex, and the inner surfaces which form the lateral walls of the foramen magnum deeply excavated. They are sessile upon the paroccipitals and at their lower anterior margins project at an elevation of fully five millimeters beyond the plane of this lower surface of the foramen magnum, so that there appears between them a deep narrow sulcus, far more pronounced than is known to the writers in any other of the mammalia except the *Rhinocerotidæ* and the *Equidæ*, where a similar fissure occurs, though not so narrow and therefore relatively deep. On the posterior surface of the occipital bone there is a well-defined ridge, which reaches its greatest development at its junction with the lambdoid ridge, where it forms a conspicuous protuberance. On either side of the occipital ridge, which rises perpendicularly from above the middle of the foramen magnum, are two lateral ridges, which extend upward and outward, terminating on the lambdoid ridge at a point on either side about equidistant from the occipital protuberance and the junction of the squamosal with the occipital. The lambdoid suture appears on the upper surface of the skull and at the middle point lies well forward of the ridge which forms the upper posterior boundary of the cranium.

The paroccipital processes are broad transversely, concave posteriorly at their

origin, and slightly bent forward at their extremities. They are wider, though not relatively as long as in the horse. The basioccipital as shown on the under surface of the skull is flatter transversely than is the case in the genera *Equus* and *Rhinoceros*, but reveals on either side two slightly elevated longitudinal ridges. In the rhinoceros there is a sharp median longitudinal keel; in the horse there are lateral ridges which unite on the median line before the anterior extremity of the bone. The posterior extremity of the basioccipital reveals an accessory condylar facet similar to that in the horse, but not extending so far forward as in the genus *Equus*. The condylar foramen is quite large and located near the border of the accessory facet.

The auditory bullæ, so far as is known from the specimens obtained by the Carnegie Museum and the University of Nebraska, were greatly inflated and lie on either side of the basioccipital and the posterior extremity of the basisphenoid.

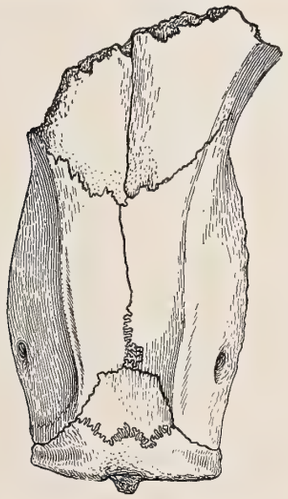


FIG. 14. Superior view of posterior part of cranium of *M. petersoni* (No. 133, Coll. of Harold J. Cook). $\times\frac{1}{3}$.

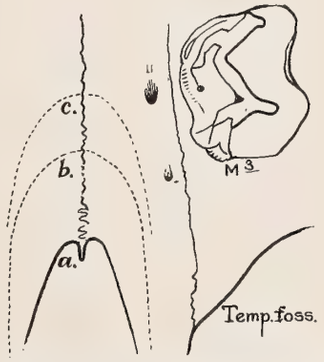


FIG. 15. Diagram showing different locations of anterior margin of posterior nares. *a, M. elatus; b, Nestoritherium; c, Macrotherium.*

So far as can be determined the auditory bullæ were ovate and did not have the form of a bent cylinder as is the case in *Macrotherium* (*cf.* Filhol, "Mammifères Fossiles de Sansan," Plate XLV, Fig. 4).

The *meatus auditorius externus* is lodged in a bony tube the outer end of which is expanded and lies just in front of the mastoid, which is relatively small and not nearly as strongly developed as in the horse or the rhinoceros. The tube narrows rapidly and passes in front of the anterior internal angle of the paroccipital, communicating with the bulla at its posterior external angle, immediately behind the well-developed pit formed for the reception of the tympano-hyal. Immediately in front of this tube is a deep sulcus between it and the postglenoid process.

The lower surface of the basisphenoid is rounded and clasped anteriorly on either side by the thin posterior plates of the vomer, which unite in the middle of the median fossa to form a thin knife-like crest. There is no suture visible between the basisphenoid and the presphenoid in the material before the writer, the two bones appearing to be, where exposed to view, thoroughly coössified. The presphenoid is almost completely covered by the posterior prolongation of the vomer much as in the rhinoceros, but with this difference that the downward projecting ridge formed by the posterior part of the vomer where it envelops the presphenoid is sharp and not rounded as in the rhinoceros, in this respect resembling the conditions which are also found in the tapir. The pterygoid processes of the basisphenoid are well developed on either side of the posterior margin of the posterior nares, coössifying behind with the basal portion of the alisphenoid. The sphenoidal fissure is well developed and even more so than in the horse, the rhinoceros, or the tapir. The *foramen lacerum medium* is bounded externally by a thin bony plate which is an anterior projection from the front wall of the auditory bulla, and which passes anteriorly into the posterior margin of the pterygoid processes. This feature of the skull recalls what is found in the skull of the bison.

The anterior limits of the palatine bones, like those in other Perissodactyla, lie opposite the anterior portion of M^2, but the backward extension of the palatines is very unusual, the anterior border of the posterior nares being much further back of the cheek-teeth than in any recent forms, suggesting conditions found in some of the Uinta Titanotheres, *e. g.*, *Dolichorhinus fluminalis* Riggs. *Moropus* differs in this respect from *Macrotherium*, where the anterior margin of the posterior nares (*la voûte palatine*) on the median line is even with the anterior internal cusp of the last molar (*cf.* Filhol, "Mammifères Fossiles de Sansan," p. 295). In *Nestoritherium* this margin lies opposite the transverse valley of M^3, and therefore in a position intermediate between those found in *Macrotherium* and *Moropus* (Fig. 15). In *Phenacodus* from the American Wasatch the posterior narial opening is further forward than in the present form, while in some extinct Artiodactyla (*Achænodon*, *Promerycochœrus*, *Pronomotherium*, etc.), the posterior nares are well back of the cheek-teeth, but in none of them as far back as in *Moropus*. The two palatines present posteriorly a U-shaped outline, the lateral sutures are very close to the alveolar border of the maxillaries, thence running backward, forming heavy processes for the contact of the pterygoids. There are numerous small foramina distributed over the surfaces of the palatine plates.

The parietal bones are long, and have a relatively smaller vertical diameter than in the recent rhinoceros or the horse, uniting anteriorly with the frontals

about opposite the glenoid cavity of the squamosals, then passing backward to the occipital plate. The supra-orbital ridges are light in *M. elatus* and *M. petersoni* and in their backward course come close together in the former, but not in the latter species. In *M. elatus* without uniting they form an inconspicuous sagittal crest, but again are divided by the triangular interparietal before they unite with the lambdoidal crest. On the posterior portion of the parietals are a number of foramina similar to those in other Ungulata (*Equus*), in fact this region of the cranium is quite suggestive of the horse, except in the lack of the emarginated area below the lambdoidal ridges beneath the inion.

The squamosal furnishes a considerable portion of the lateral walls of the brain-case. Posteriorly and inferiorly the sutures are not very distinct in the material before us. However, the squamosals appear to form the base of the lambdoidal crests for about five and a half centimeters back of the external auditory meatus. The zygomatic process is quite heavy and does not extend forward as far as in the horse or the rhinoceros, in the former of which it enters into the lower posterior margin of the orbit. In this respect *Moropus* more nearly presents the condition found in the tapir. The postglenoid process suggests that of the horse, though proportionally much heavier and especially well developed in its transverse diameter, in this respect somewhat closely resembling the genus *Phenacodus*. In the tapir the postglenoid process lies obliquely to the long axis of the skull, while in *Moropus* it lies nearly at right-angles to the axis. In the rhinoceros (*R. bicornis*, and *simus*) it is very prominent and elongated. The glenoid cavity of *Moropus* is a broad flat surface which gradually shades into the inferior border of the zygomatic arch without much indication of a well-defined anterior border of the articulating surface, such as is found in the horse, and other recent Perissodactyla.

The frontal bone has a triangular outline with the sutures well indicated in the material before us. Anteriorly the sutures of the two bones together form a sinuous curve across the face, the median portions of the bones projecting the farthest forward, somewhat more so than in the recent horse. Laterally the superior border of the orbit is heavily developed, overhanging, and perforated by a large foramen somewhat similar to that occurring in the skull of the horse, as already mentioned by Peterson in an earlier publication,[17] the superciliary ridge being, however, much heavier than in the horse. There is a slightly developed postorbital process. The orbit is, however, open posteriorly, as in the rhinoceros and tapir, and as in these genera is located well forward in comparison with the

[17] Peterson, O. A., Amer. Naturalist, Vol. XLI, 1907, pp. 737–738.

position of the eye of the horse. Supratemporal ridges only appear upon the posterior portion of the frontals a little before their union with the parietals. Over and back of the eyes the frontal bones show a broad convex area between which is located a shallow depression in the median line. The suture between the frontals and the parietals lies at right angles to the axis of the skull, much as in the horse and the rhinoceros.

The nasals are of considerable size, especially behind, where they form a broad surface across the lower portion of the face. The greatest posterior extent of the curved fronto-nasal suture is opposite the anterior margin of the orbits, while laterally the nasals are suddenly bent downward as in the horse, thus furnishing a considerable portion of the side of the muzzle and also forming a long sutural contact with the maxillaries and the lachrymal bones. The anterior portions of the nasals were broken off when the specimen (No. 2103) was found, but it is evident from what remains that the external margins of the nasals at their extremities were, so to speak, bifid, *i. e.*, there was a lateral external process developed posterior to the anterior extremity of the nasals, plainly indicated in No. 2103. This feature is well shown in the figure of the skull of *Moropus* published by Osborn, Bull. Am. Mus. Nat. Hist., Vol. XXXII, p. 263 (1913). The general features of the skull in this region, *i. e.*, the long slope of the narial border of the maxillaries, and the slope of the nasals themselves indicate that the bones were not of very great length. In the model of the skull they are terminated approximately as in the horse (see Plates LIII and LXXIII).

The lachrymal occupies a considerable portion of the side of the face; in size and shape it quite closely suggests that of the horse and the rhinoceros. Inferiorly it is bounded by the jugal, anteriorly by the maxilla, and superiorly by the nasals and frontals. The bone undoubtedly enters into the composition of the anterior border of the orbit, but in the crushed condition of the skull (No. 2103) it is not possible to exactly define to what extent this is the case. In the model from this skull its outline is approximately given (see Plate LIII). The size and position of the lachrymal foramen is not ascertainable from the material before us.

The jugal takes up about the same proportion of the face as in the horse, but it is much closer to the alveolar border inferiorly. Its zygomatic process, though comparatively light, is heavier, and there is, as in the tapir, a slight postorbital process which is not reached by the process of the squamosal, as in the rhinoceros. Anteriorly there is a slightly convex area in front and below the orbit, but the masseteric ridge of the jugal does not continue forward on the maxillary bone as in the horse. Its orbital border is smooth, transversely thick, and gently rounded.

The maxillary is of large size and in general outline closely suggests the same bone in the genus *Equus*. As in the latter the ascending process furnishes the greater portion of the side of the muzzle and is joined superiorly by the lachrymal and the nasal, as stated above. The infra-orbital foramen is of considerable size, larger than in *Equus*, though not as large as in *Rhinoceros* and *Tapirus*, and is located over the anterior portion of M^2. The size of this foramen indicates a more liberal exit for and perhaps a greater supply of blood to the upper labial muscles than in the horse. The upper portion of the narial border is rather thin; it does not indicate any sutural contact with the premaxillary, and the border as a whole indicates a more gradual slope than it does in a younger specimen previously described.[18] The anterior ends of both maxillaries are broken off; the right a short distance in advance of the cheek-teeth. There is a diastema of considerable length between the cheek-teeth and the maxillo-premaxillary suture, judging from the correspondingly long diastema of the lower jaw. The alveolar border is quite long and is occupied by a set of powerful teeth. Back of M^3 there is an unusually long and heavy extension of the alveolar border quite unusual in the Perissodactyla. These processes of the maxillaries which project backward, furnish much lateral contact for the palatine plates, the extraordinary posterior development of which has already been pointed out. Externally the maxillary presents an even and gently convex surface over the cheek-teeth both supero-inferiorly and in the antero-posterior direction, there being, as stated above, no perceptible masseter crest as in the horse. The palatine plates have the same degree of transverse concavity as in the horse, and in the present genus they furnish approximately one-half of the palate between the cheek-teeth. Beyond the molar-premolar series the maxillaries are wanting in our specimen.

The premaxillary of *Moropus*, as stated by Peterson (*l. c.*, p. 740), is not known. However, judging from the long slender symphysis of the lower jaw, these bones were undoubtedly of considerable extent. They may have been edentulous, though, as pointed out by Peterson, the "lower jaws of adult specimens with incisors in place always show wear on the median pair, while the lateral teeth are almost entirely unworn" (*l. c.*, p. 740, *foot-note*). When making the restoration represented on Plate LIII two small median incisors were inserted by the senior author, who modelled the skull. They may or may not have existed in nature, but the constant wear at right angles to the axis of the procumbent lower incisors seems to suggest that they must have met with some opposition, which it seems most reasonable to suppose to have been that of teeth located in the upper jaw.

The genus *Macrotherium* had a relatively shorter skull. In this genus,

[18] Peterson, O. A., Amer. Naturalist, Vol. XLI, p. 740.

moreover, the different processes are heavier than in *Moropus*. The postglenoid process in *Macrotherium* is more rounded, while in *Moropus* it possesses a greater transverse and a less antero-posterior diameter. The tympanic bulla in *Macrotherium* is larger, different in shape (curved semi-cylindrical), and differently located in relation to the median axis of the skull; the paroccipital process also is relatively heavier and shorter, the occiput higher, and the sagittal crest more prominently developed in the latter genus. The skull which is the type of *Nestoritherium* has been crushed almost in the same manner as the skull of *Moropus elatus*, which has been described, but the two skulls show striking similarities in the breadth of the frontals over the orbits, their contours above, the shape and length of the nasals, maxillaries, and palatines. The posterior nares, however, extend further forward in *Nestoritherium* than in *Moropus*.

MEASUREMENTS[19] OF THE CRANIUM OF *Moropus elatus* (No. 2103, Catalog Vert. Foss., Carnegie Museum).

	cm.
Diameter from the occipital crest to and including P^2	52
Diameter from the occipital condyle to and including P^2	49
Diameter from the occipital condyle to M^3	28
Diameter from the occipital condyle to anterior margin of orbit	30
Transverse diameter of palate at P^2	6
Transverse diameter of palate at M^3	8
Greatest expansion of the zygomatic arches	27
Transverse diameter at base of postglenoid processes	19
Transverse diameter at paroccipital processes	13
Transverse diameter of occipital condyles	10
Vertical diameter of occipital condyles	5
Transverse diameter of frontal over the orbits	26
Transverse diameter of occiput	13

THE MANDIBLE.

(Plate LII.)

In general outline the lower jaw of *Moropus* suggests that of *Equus*, but an examination of the details of structure shows marked differences between the two genera. The diastema between the incisors and cheek-teeth is long, as in the horse, and the alveolar border for the incisors is elevated to about the same degree, so that the incisor teeth are in a similar procumbent position; the external face of the horizontal ramus is, however, slightly more convex, though not nearly so much so, as in the tapir. The inferior border again forms a straight line as in *Equus*, but the angle has not the downward projection, nor is its lower border so heavy, or everted, as in the fully adult horse. Thus the inferior and posterior

[19] These measurements are taken from the skull in its crushed condition and some may be somewhat greater than they would otherwise be.

borders of the lower jaw form a more nearly perfect right angle in *Moropus*. Back of the incisors the long and rather delicate ramus of the lower jaw is much constricted laterally as in the horse. The mental foramen is also sometimes

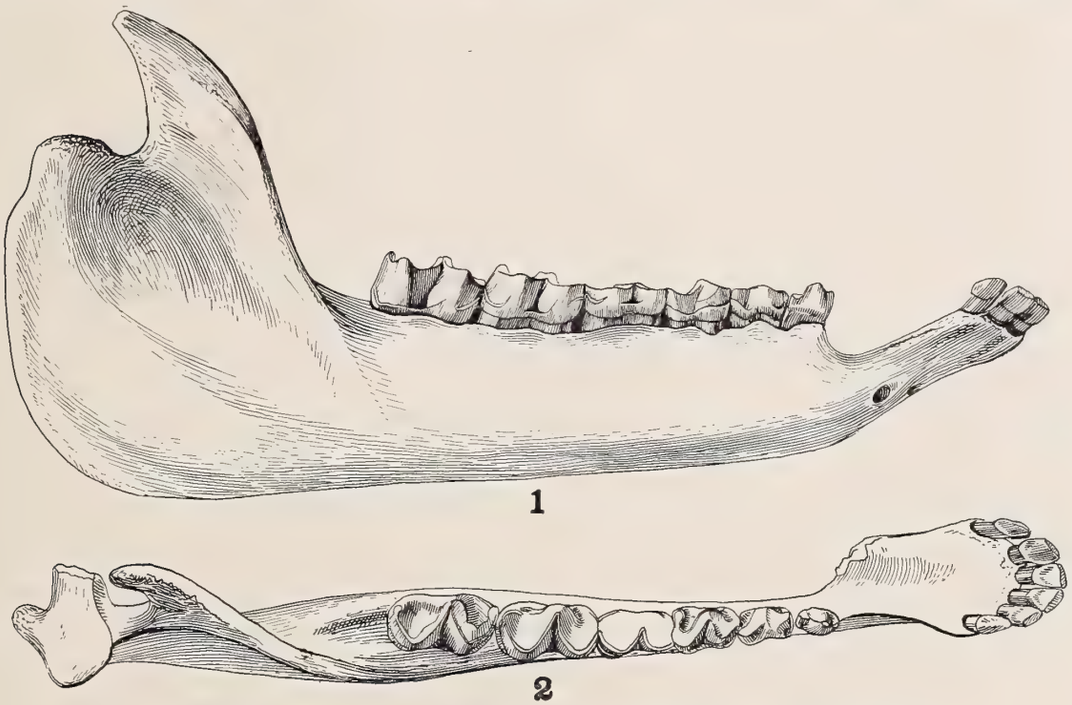


FIG. 16. Mandible of *M. petersoni* (?) (No. 1758). 1, external view; 2, superior view. $\times\frac{1}{3}$.

located immediately back of the greatest constriction, as in *Equus*. The position of this foramen is, however, variable in *Moropus*, and there are generally two and sometimes three foramina distributed on the external and lower faces of the constricted area of the ramus. The alveolar border is suddenly raised above the diastema, in this respect differing from the horse in which the border of the diastema rises more gradually. Along the external margin of the alveolar border of the lower jaws of specimen No. 1604 there is a prominent ridge, which is generally less developed in younger individuals. The internal face of the horizontal ramus is slightly more convex than in the horse and more nearly like that of the tapir. As in the horse, there is a liberal space on the alveolar border between M_3 and the base of the coronoid process, but *Moropus* differs in having this portion of the ascending ramus much heavier, and also in having a much larger, more rugose, and deeper anterior fissure for muscular attachments; in consequence the external and internal margins at the base of the coronoid process are much heavier than in the recent horse, and the external margin flares outwardly as it does not in the horse.

The external face of the ascending ramus has not the rugose surface and everted sharp lower margin of the angle supporting the masseter muscle seen in *Equus;* on the other hand, the temporal fossa is deeper and fully as large. The coronoid process is of considerably greater antero-posterior diameter than in the horse, projecting backward to about the same extent, but terminates in a trihedral point. The sigmoid notch has nearly the same proportions as in *Equus*, while the region of the condyle is heavier. The articulating surface of the condyle itself is quite flat in order to conform to the glenoid cavity of the skull already described. Immediately below the condyle on the inner side is a deep groove for the protection of the blood-vessels. There is a tubercle on the lower border of this groove as in the horse, but more strongly developed than in the latter animal. The pterygoid fossa is deeply excavated and its rugose surface provides abundantly for the attachment of the muscles. The dental foramen is of large size, in order to provide sufficient nourishment for the heavy dentition of the inferior maxillary.

The lower jaw of *Nestoritherium* reveals a strong general resemblance in its configuration and proportions to that of *Moropus*, but in *Nestoritherium*, and to a less extent also in *Macrotherium* there is a tendency to a thickening of the lower margin of the mandible. The outer and inner margins of the ramus in *Moropus* are evenly curved from above downward, whereas in the European genera there is externally a lateral ridge extending nearly the whole length of the ramus, and internally a corresponding shallow fossa, no trace of either of which is found in the numerous lower jaws of *Moropus* before us. The mandible in *Macrotherium* is proportionally shorter and more robust than in the American genus, the muzzle of which was undoubtedly longer and more pointed. In *Circotherium* the mandible is shorter still, without incisors, and the diastema between the premolars and the canine much shorter than the diastema between the premolars and the incisors in *Moropus*.

Measurements of Mandible.

	No. 1604 (*elatus*), mm.	No. 1758 (*petersoni*), mm.
Total length of the lower jaw, incisors included	500	434
Length of mandibular symphysis	103	88
Diameter from angle of jaw to and including P_2	385	334
Diameter from angle of jaw to and including M_3	185	159
Depth of ramus at diastema	30	28
Depth of ramus at P_2	60	58
Depth of ramus at M_3	80	68
Depth of ramus at coronoid process	230	197
Depth of ramus at condyle	180	138

The Dentition.

(Plates XLVIII–LIII.)

The Superior Dentition.

(Plates XLVIII, XLIX, and LI.)

The absence or presence of superior incisors in *Moropus* cannot now be definitely determined. The premaxillary bone has not been found in any specimens thus far recovered, and we have yet to learn whether the wear of the median lower incisors is caused by meeting a median upper pair, as represented on the model (see Plate LIII), or whether this abrasion is caused in some other way. There is no superior canine, as shown by skull No. 1707. The long edentulous premaxillary-maxillary border is succeeded by a series of large teeth covered with thick enamel and implanted in the jaw by long powerful roots. The archaic Perissodactyl type and structure of these cheek-teeth is recognized, and it is with *Palæosyops* and *Titanotherium* that they have generally been compared. The structure and modification, especially of the premolars, is, however, quite different from that of the latter genera and merely indicates a parallelism. P^1 is absent, as is also the case in the known European and Asiatic forms. P^2 is triangular in general outline, the proto- and tritocones have united to form a solid ectoloph in the formation of which the protocone plays the most prominent part, forming the apex of the external wall without dividing this portion of the crown by a transverse valley as seen in *Titanotherium* and many other Perissodactyls. On the antero-internal angle the cingulum has developed into a protoloph of considerable functional importance, which in earlier European forms, *e. g.*, *Schizotherium priscum*, appears to be wanting so far as is known. This is also true of *Chalicotherium goldfussi*. The metacone is much more developed, and, on further wear, is connected with the ectoloph as a broad functional metaloph, somewhat as seen in the *Rhinocerotidæ*, including the median cross-valley which separates proto- and metalophs. The metaloph is surrounded by a heavy cingulum, which continues forward to form the protoloph already described. The latter appears to have a varied development in different individuals. Externally the tooth has little or no cingulum. P^3 differs from the preceding tooth (1) by being more quadrate in general outline, (2) by having one instead of two tubercles. As in the tooth previously described, the ectoloph presents a broad transverse surface on the grinding face. The ectoloph is separated from the internal cone (deuterocone) by a wide longitudinal valley and a deep pit. The deuterocone itself is very prominent and sometimes has

well-defined ridges of enamel extending from the base of the tubercle to the apex. There is a well-developed cingulum which is visible near the antero-external angle of the ectoloph and continues to the internal face of the deuterocone, where it sends a heavy fold to very nearly the apex, thence continuing again to the postero-external angle of the ectoloph. Externally the cingulum is not nearly as prominently developed. P^4 is slightly larger than the preceding tooth, while the structure is otherwise very similar. The antero-external angle of the ectoloph is generally more developed in the last premolar, and there is usually also found a more prominently developed ridge of enamel from the apex of the protocone some distance up on the external face of the tooth. The deuterocone and the cingulum are developed in the same proportion as in the preceding tooth. The cheek-teeth gradually increase in size toward the back of the jaw. The premolar series takes up less than one-half of the space which is occupied by the molars, thus differing entirely from conditions found in the Perissodactyla in general, where the length of the premolar and molar series is more nearly subequal. In the European *Schizotherium priscum* from the phosphorites of Quercy (Oligocene) the premolars occupy relatively a greater space.

M^1 is much enlarged, more especially in the antero-posterior direction. The general configuration of the crowns is as suddenly changed from that of the premolars as is the size. The external face of the ectoloph suddenly takes on the W-shaped form so characteristic of the molars of the *Titanotheriidæ* with which those of the *Chalicotheriidæ* have often been compared. The metacone is a large bunodont tubercle with an external exit of the cross-valley in front and back of it. The anterior face has a very prominent and rather smoothly rounded cingulum, which continues inwards and backwards and terminates at the exit of the anterior cross-valley. The posterior cross-crest is divided into an outer and inner lobe separated by a postfossette. On M^1 this fossette is generally very soon obliterated by wear, the crest being often entirely bisected so as to form a valley between the ectoloph and the hypocone. At the posterior base of the metacone there is usually a smoothly rounded cingulum extending downward toward the exit of the posterior cross-valley. Posteriorly the cingulum forms a shelf at the exit of the postfossette, while at the base of the ectoloph there is a light cingulum. M^2 is one-fifth longer than the tooth just described. The fold of the ectoloph is more conspicuous, the postfossette is deeper, the posterior face more backwardly extended, and the ledge-like cingulum broader than on M^1; otherwise there are little or no differences in the general construction of the two teeth. M^3 is only very slightly longer than the preceding tooth, but otherwise there is little or no difference in the configuration of the crowns.

Measurements of Superior Dentition.

	No. 2103 (*Moropus elatus*), mm.	No. 10030 Y.M (*M. oregonensis* type), mm.
Length of premolar-molar series	218	..
P^2 antero-posterior diameter	22	..
P^2 transverse diameter	20	..
P^3 antero-posterior diameter	24	17
P^3 transverse diameter	29	20
P^4 antero-posterior diameter	26	18
P^4 transverse diameter	30	23
M^1 antero-posterior diameter	43	..
M^1 transverse diameter	34	23
M^2 antero-posterior diameter	56	..
M^2 transverse diameter	41	..
M^3 antero-posterior diameter	59	37
M^3 transverse diameter	42	33

In comparing the measurements of *Moropus* with *Macrotherium* it is at once observed that the latter has much shorter and broader molar teeth. This also appears to be true of *Chalicotherium goldfussi* and of the Asiatic species, so far as the limited material permits of comparison. On the other hand it is of interest to note that in *Schizotherium priscum* and *Nestoritherium pentelici* the molars are longer than wide, in this respect more nearly approaching the American type.

In *Macrotherium grande* the premolars show less complication in the details of structure, especially P^2, the first in the series. It has the outline of the crown less triangular than in *Moropus*. Internally it is also somewhat less developed, forming an oblique longitudinal valley between the ectoloph and internal tubercle, instead of a basin as in the American species.

The anterior external angle of the molars in *Macrotherium* is not developed as much as in *Moropus*, so that the tooth in the former genus is more quadrate in outline than in the latter; the molars are decidedly shorter, and the median fossa, which separates the anterior and posterior inner tubercles, is directed more obliquely inward and backward. Nevertheless the general configuration of the crowns is on the whole quite similar in the two forms.

The Inferior Dentition.

(Plate LII.)

Moropus elatus has three incisors on either side, which are somewhat like those in *Equus*. The lateral expansion of the crowns is, however, much less than in the

recent horse, the roots are less curved, and the crowns generally have received little wear, except in the case of old individuals in which the median pair, and sometimes the second pair, have received wear at the points of the crowns, which may indicate that there were upper incisors. The incisor series has a procumbent position not unlike that in the recent horse, though the transverse diameter of the symphysis is considerably less than in *Equus*. There is no canine in *Moropus*, nor in *Nestoritherium*, so far as known; but in *Macrotherium* and in *Circotherium* there is a well-developed canine, in the former genus located close to the incisor series, in the latter genus rising prominently at the posterior edge of the edentulous incisive alveolar border and separated from the premolars by a moderately long diastema. In *Moropus* there is a long diastema back of the incisors, which is succeeded by a series of well-developed cheek-teeth corresponding to the large upper teeth. The lower cheek-teeth are on the whole more nearly like those in *Titanotherium* than are the upper. P_1 is absent. P_2 is quite simple and much reduced, while P_3 has the typical molariform pattern observed in P_2 of *Titanotherium*. In the lower jaws which belong with the cranium associated with No. 1604 the dentition is very much worn, especially the premolars, so that the detailed structure of the crowns is less distinct, but other specimens are more perfect in this respect. P_4 is much increased in the antero-posterior direction and has the complete W-shaped character of the crown, the postero-internal angle being especially well developed. Externally the cingulum is well developed, while internally the tooth is nearly smooth; this is also true of P_3.

M_1 of specimen No. 1604 is very much worn; its antero-posterior diameter is considerably greater than that on P_4; the crowns of the two teeth are otherwise quite similar, except that on M_1 the hypoconid is more developed; while the cingulum is less prominent. M_2 is longer, but is otherwise of the same general pattern as the tooth preceding it; the cingulum, however, is more prominently developed on the external and posterior faces of this tooth. M_3 lacks the third lobe which is of the usual pattern seen in the European and Asiatic species of this family. Externally and posteriorly the cingulum is well-developed, while internally the tooth is more or less smooth.

MEASUREMENTS OF *Moropus elatus* (Car. Mus. Cat. Vert. Foss. No. 1604).

	Mm.
Length of premolar-molar series	202
Antero-posterior diameter of crown of I_1	9
Transverse diameter of crown of I_1	11
Transverse (greatest) diameter of crown of I_2	12
Transverse (greatest) diameter of crown of I_3	9
Antero-posterior diameter of P_2	19

Transverse diameter of P_2	12
Antero-posterior diameter of P_3	25
Transverse diameter of P_3	16
Antero-posterior diameter of P_4	28
Transverse diameter of P_4	20
Antero-posterior diameter of M_1	36
Transverse diameter of M_1	24
Antero-posterior diameter of M_2	47
Transverse diameter of M_2	27
Antero-posterior diameter of M_3	53
Transverse diameter of M_3	29

The Deciduous Dentition.

(Plate LI.)

M. petersoni Holland (No. 1707).

A number of individuals in the collection represent the deciduous dentitions in different stages of development. The greater portion of a cranium, No. 1707,[20] has the milk-teeth perhaps most completely preserved. D^2 has a much greater antero-posterior and less transverse diameter than the permanent tooth. This is chiefly due to the prominent protostyle, which forms a sharp crest on the antero-external angle uniting with the protocone, thus presenting a long ectoloph. Internally there are two tubercles, the posterior the more prominent and separated

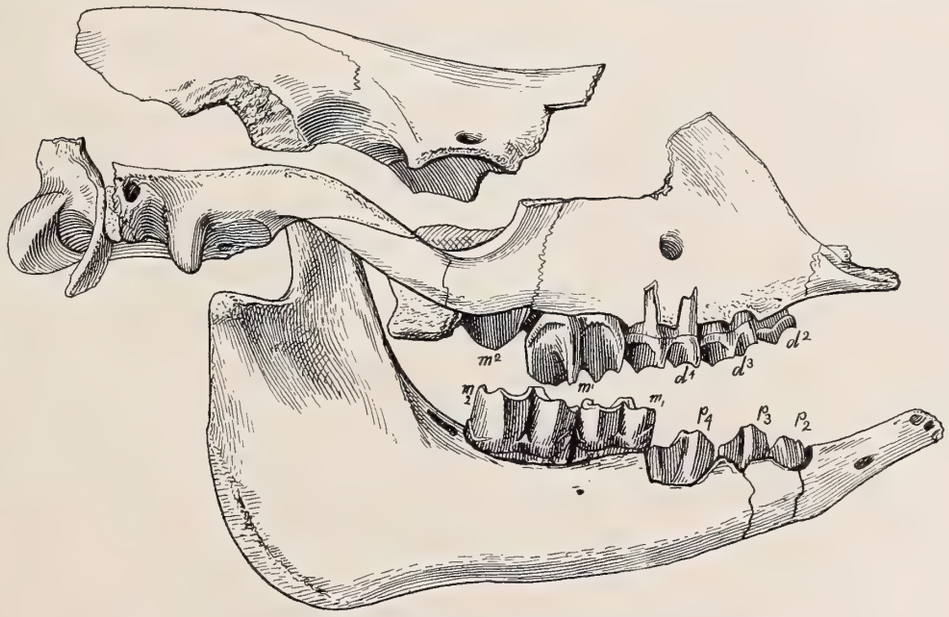


FIG. 17. View of right side of skull of *M. petersoni* (No. 1707). ×⅓.

[20] This cranium was described by O. A. Peterson in the Amer. Naturalist, Vol. XLI, 1907, pp. 733–752.

from the ectoloph by a valley, while the one anterior adheres quite closely to the internal face of the protocone, thus forming an inwardly slanting cross-crest. Posteriorly and internally the tooth is surrounded by a heavy cingulum, while externally it is lighter. D^3 and D^4 increase progressively in size, and are, as stated by Peterson (*l. c.*, p. 742), more nearly molariform than are the permanent series, which may be observed in the illustrations (see Pl. LI, and Fig. 17). In the specimen (No. 1707) the germ of P^2 is not nearly as far advanced in development as those of P^3 and P^4, as has been plainly brought to light by an excavation which has been made close to the alveolar border.

The inferior milk-incisors are not present in the material at hand, but they were most likely there on either side. D_2 has a rather long narrow crown, so that in an unworn state the tooth presents a somewhat trenchant crown. D_3 is twice as long as the preceding tooth and is completely molariform in every respect. D_4 is very little longer than the preceding tooth, but has a greater transverse diameter; there is otherwise little or no difference between the two teeth. The cingulum is only very slightly developed on the antero-external angle of D_3 and D_4 and on the posterior face of D_4. Internally the teeth are generally quite smooth.

The Vertebral Column of Moropus.

There are seven cervicals, fifteen dorsals, six lumbars, and four sacrals in the vertebral column of *Moropus*. The number of caudals is not known. Judging from the size and shape of the sacrals and the distance to be covered by the caudal series in order to form only a very short tail, there must have been at least twelve caudals. Unfortunately no caudals which can be positively referred to the specimens in our possession have been found. The tail which has been affixed to the mounted specimen is a work of fiction, and while quite probably approximating the facts of nature, must not be accepted by students as anything more than a scientific surmise.

The cervicals of *M. elatus* are relatively very massive; those of *M. petersoni* much less so. The centra of the axis and the three succeeding vertebræ are laterally deeply excavated and their support comes from a narrow and vertically deep keel-like ridge on the lower side. The sixth is very broad below, with a great expansion of the lateral processes. The seventh is relatively short, and reveals an abrupt transition from its predecessors in order to accommodate itself to the dorsal series immediately following it. One of the most noticeable features of the cervical series is the fact that, with the exception of the atlas, they all have the posterior articular surface of the centrum produced below so as to form a cup-like depression,

which looks more nearly upward and not backward to the same degree as in most mammals. An approximation to this feature is to be found in the cervicals of the horse and the tapir, but, so far as our observations extend, is not to be observed in so great a degree in any other of the recent mammals. The spine of the axis is very massive. The spines of the third, fourth, and fifth cervicals are also massive, low, but gradually increasing in height, that of the sixth cervical being a little higher than that of the fifth, while the spine of the seventh suddenly increases in height, and is sharply attenuated at its extremity.

The spines of the anterior dorsals rapidly increase in height to the fourth, and then as rapidly decline in height until the eighth is reached. The spines of the dorsals from the ninth to the fifteenth are uniform in height. All of the spines of the dorsals rake backward, more so in *M. petersoni* than in *M. elatus*. The spines of the lumbars slowly increase in height from the first to the fourth and then grow shorter as the sacral series is approached. The spines of the sacrals rapidly diminish in height backward. The spines of the lumbars are nearly perpendicular, those of the sacral series have a backward rake.

The transverse processes of the first dorsal are massive and tubercular. A rapid diminution in the size of the latter processes takes place in the second and third dorsals, after which the transverse processes of the succeeding vertebræ maintain nearly the same size, gradually showing a tendency to divide into two tubercles, which division finally becomes pronounced in the last three dorsals, and reaches its highest development in the lumbars, in which the transverse processes become broad, long, and attenuated horizontal projections steadily increasing in length to the sacrum. The upper process, or metapophysis, in the lumbars bears the prezygapophysial face for articulation with the preceding vertebra.

A single caudal, which cannot be referred to the genera *Diceratherium*, *Dinohyus*, *Stenomylus*, the carnivora, or other animals, remains of which were found in the same quarry with the remains of *Moropus*, has been provisionally accepted as representing the type of the anterior caudal vertebræ in *Moropus*.

The Cervical Vertebræ.

The cervical vertebræ of *M. elatus* (No. 1604), seven in number, were all recovered near to each other, and fit so exactly, being in no wise crushed or distorted, as to make it quite an easy task to assemble them. They plainly belonged to the same individual.

Cervical vertebræ belonging to other individuals were also recovered, though not always in as perfect condition, or in as complete a series, as those just men-

tioned. They belong to smaller and in some cases evidently immature individuals. These cervicals for purposes of study and comparison have been arranged in series, and although it is not absolutely certain in all cases that in this arrangement the vertebræ belong to the same individual, the arrangement is nevertheless useful for purposes of investigation and description. The series thus formed may be enumerated as follows:

Catalog No. 1703 A (*M. petersoni* Holland).

This series consists of an atlas, axis, and the third, fifth, sixth, and seventh cervicals. They are all in remarkably good condition, having sustained very little crushing and breakage. The spine of the fifth cervical is missing, and there are a few very minor injuries, which have been sustained at the outer extremities of some of the lateral processes. It may be said in passing that this series of cervicals has been associated with a series of dorsals and lumbars bearing the catalog number 1703 *B* and *C*. The size, texture, and color of the bones in these cervicals, dorsals, and lumbars conspire to suggest that they all belong to one individual.

Catalog No. 1713.

The cervicals grouped under this catalog number consist of the atlas, the axis, and the last three cervicals. The atlas and axis are in a good state of preservation. The posterior cervicals are in a more or less fragmentary condition; they evidently belonged to a large, but somewhat immature, individual, as the epiphyses of the axis and of the vertebræ associated therewith are lost. It is to be observed that associated with this cervical series, under the same catalog number, are numerous dorsals and lumbars which it is highly probable belonged to the same individual.

Catalog No. 1720.

Under this number are placed an atlas, axis, and the fifth, sixth, and seventh cervicals. The atlas has been somewhat injured on its upper surface, the neural arch having been destroyed. The remaining vertebræ have lost the posterior epiphyses and have sustained other minor injuries. The specimens are relatively quite small in size, and evidently belonged to an immature individual.

Catalog No. 1721.

This series consists of a very well preserved atlas, and the seventh dorsal, together with fragments which probably represent the fifth and sixth cervicals. These specimens, like the foregoing, belonged to a small individual, evidently quite immature, inasmuch as both the anterior and the posterior epiphyses of the centra have been lost.

Catalog No. 1722.

This consists of a small and quite perfect atlas, and the third, fourth, and seventh cervicals. The bones belonged to a small and very immature individual, and with the exception of the atlas, are not in very good condition, having been somewhat broken.

Catalog No. 1722A.

This consists of the fourth, fifth, and seventh cervicals of a quite small and immature individual. All the bones are in a somewhat fragmentary condition.

Catalog No. 1723.

The series placed under this number consists of the third, fourth, and fifth cervicals, a fragment of the sixth (?), and a seventh cervical. The latter is in comparatively good condition, as is also the fifth. The other members of the series are more or less fragmentary. The specimens represent an individual of small size, retaining the posterior and anterior epiphyses, thus indicating a maturer development than in the two preceding series, which have been mentioned.

Catalog No. 1724.

The specimens assembled under this number consist of a very well preserved atlas, an axis, and the third, fourth, and fifth cervicals in a more or less broken condition. The specimen to which these bones belonged was apparently somewhat smaller in size than the specimen accessed as No. 1723, and the posterior epiphyses of the centra have all slipped.

Catalog No. 1725A.

This series consists of an axis, together with the fourth, fifth, and sixth cervicals. The axis is in fairly good condition. The other vertebræ have sustained extensive injuries through breakage. The bones represent an individual of medium size.

Catalog No. 1726.

This consists of a single atlas of quite small size, but in perfect condition.

Catalog No. 1727.

Under this number has been placed a large and beautifully preserved atlas.

Catalog No. 1728.

Under this number there has been cataloged a medium-sized, but singularly perfect atlas.

Catalog No. 1729.

Under this number has been cataloged an atlas intermediate in size between Nos. 1727 and 1728.

The cervicals in their relative size, in the possession of a deep inferior keel-like projection, and in their manner of articulation are decidedly equine in appearance, though the inferior keel is in most specimens relatively much deeper vertically than in the horse, and posteriorly widened laterally, giving the posterior extremity of the keel a triangular form which is not seen in the horse. The posterior articular surfaces of the centra of the cervical vertebræ from the second to the sixth look upward far more strongly than is the case in the horse, or for that matter in any other mammal with which the writers are acquainted. The method of articulation displayed by the cervical vertebræ shows that the animal was able easily to reach the ground with his incisors while in a standing position.

The Atlas.

Eleven specimens of the atlas of *Moropus* were recovered, all of them differing in size and some of them being better preserved than others. The largest specimen, No. 1604, belonging to the mounted skeleton (see Figs. 18–20) has an extreme width, measured over the transverse processes, of twenty centimeters. The smallest specimen, No. 1726, has an actual width of approximately eleven and a half centimeters, but, as the right transverse process is broken, the true measurement in life was not less than twelve and a half centimeters. It evidently belonged to an immature individual.

Fig. 18. Lateral view of atlas of *Moropus elatus* (No. 1604). ×⅓.

A comparison of the various specimens shows considerable variation in the relative width of the upper anterior marginal sinus between the condylar articular surfaces. In specimens Nos. 1604, 1728, and 1726, selected for detailed measurements, this sinus is in each case of nearly the same width, but in specimen 1721, which is undoubtedly the atlas of a very immature animal, the sinus is thirty-seven millimeters wide, while in most of the other specimens not enumerated here it is only about twenty-five millimeters in width.

The anterior articulating surfaces are widely separated above, but more closely approximate each other below, being separated by a notch, which in one specimen, No. 1724, is produced downward as a deep narrow cleft. Only vestiges of this deep cleft appear in specimens Nos. 1713, 1722, 1727, and 1728, while in all others it is wholly obliterated, being solidly filled in with bone. The vertical

diameter of each condylar articular surface is greater than its transverse diameter, and they become narrower below. They are vertically and horizontally very deeply concave, forming a cup-like cavity for the reception of the condyles.

The posterior articulating surfaces are in all the smaller specimens subrotund, but in the larger specimens, owing to the increasing width of the atlas, without a

FIG. 19. Superior view in outline of atlas of *Moropus elatus* Marsh. $\times\frac{1}{3}$. (C. M. Cat. No. 1604.)

FIG. 20. Inferior view in outline of atlas of *Moropus elatus* Marsh. $\times\frac{1}{3}$. (C. M. Cat. No. 1604.)

corresponding relative increase in the vertical diameter, these surfaces tend to become more or less oval in outline. They are convex horizontally and vertically and look inwardly.

The articulating surface for the odontoid process of the axis is somewhat triangular in outline, with its external boundaries poorly defined in all specimens. The margins of all the other articulating surfaces both before and behind are well defined.

The transverse processes of the atlas are broad and wing-like. Their outer margins in the smaller and younger specimens are thin, but in the larger and older specimens the margins become thickened at their anterior and posterior extremities.

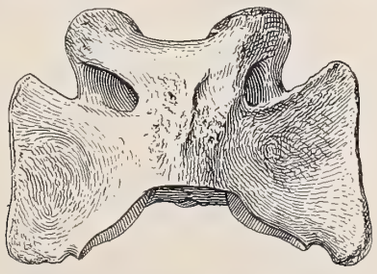


FIG. 21. Superior view of atlas of *M. petersoni* (No. 1703*A*). $\times\frac{1}{3}$.

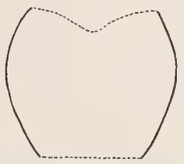


FIG. 22. Diagram representing contour of neural canal of axis of *Moropus elatus* in horizontal section.

On the median line on the upper side of the superior arch there is in all specimens a slightly raised bony ridge, representing the dorsal spine. This is most conspicuous in specimens Nos. 1724, 1728, and 1729.

Exit for the first pair of spinal nerves is furnished by the large foramen located above on either side just behind the point where the inner margin of the condylar surface joins the superior arch. This foramen is succeeded externally by a deep groove, which passes forward and downward through the notch between the anterior lip-like projection of the anterior articulating surface and the anterior prolongation of the lateral process, and then may in some specimens be traced backward on the under surface of the transverse process to the deep fossa which lies on either side before the opening of the vertebrarterial canal.

The vertebrarterial canal passes through the posterior half of the transverse process along the line of union with the body of the bone, emerging behind at the point where the posterior articulating portion of the atlas forms a notch with the

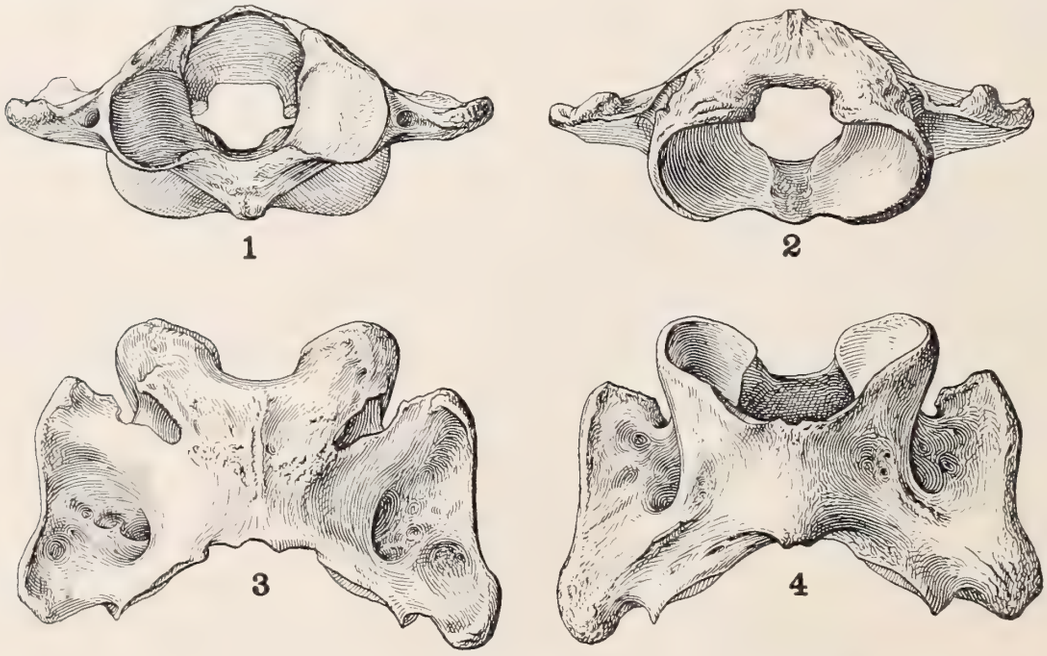


FIG. 23. Atlas of *Moropus elatus* Marsh (C. M. Cat. No. 1604). $\times \frac{1}{3}$. 1. Posterior view. 2. Anterior view. 3. Superior view. 4. Inferior view.

posterior extremity of the transverse process. This arrangement of the foramen transversarium, so far as the writer has been able to ascertain, differs from that found in many recent mammalia, where the vertebrarterial canal is represented in the atlas by a foramen piercing the alæ about the middle, but is precisely that which occurs in the case of the Felidæ, the Tapiridæ, and Camelidæ, and in *Entelodon*, *Trigonias*, *Dinoceras*, and the Titanotheres among extinct forms. In almost all specimens there appears on either side below the transverse process and midway between the anterior notch and the anterior opening of the vertebrarterial canal a

nutrient foramen of considerable size leading upward into the body of the superior arch.

The neural canal of the atlas is narrower behind than in front and is expanded internally at the middle on either side. In specimen No. 1604 the transverse diameter between the condylar articular surfaces is fifty-three millimeters; the transverse diameter between the lateral faces for the axis is forty-three millimeters; while the transverse diameter within and midway between the anterior and the posterior openings is seventy millimeters. The diagram reproduced in Fig. 22 represents the contour of the neural canal at its middle as shown by a horizontal section.

Measurements of the Atlas.[21]

	No. 1604 (mounted specimen, ♂), mm.	No. 1728 (medium sized, adult? ♀), mm.	No. 1726 (immature, sex undeterm.) mm.
Greatest transverse diameter	200	146	*125*
Greatest vertical diameter	88	77	55
Transverse diameter of the neural canal behind	43	39	38
Vertical diameter of the neural canal behind	57	49	38
Antero-posterior diameter of the superior arch	65	52	36
Vertical diameter of superior arch at the middle	15	9	9
Antero-posterior diameter of inferior arch	51	40	30
Vertical diameter of inferior arch at the middle	24	21	11
Vertical diameter of faces for occipital condyles at middle	50	40	37
Horizontal diameter of faces for occipital condyles at middle	50	39	34
Vertical diameter of faces for the occipital condyles where they approximate each other	28	15	9
Distance between faces for occipital condyles above	33	32	31
Distance between faces for occipital condyles below	11	10	6
Diameter of face for odontoid process	22	15	12
Vertical diameter of lateral faces for axis at middle	42	37	36
Horizontal diameter of lateral faces for axis at middle	66	51	36
Distance between outer margins of lateral faces for axis	120	95	89
Vertical diameter of foramen for first spinal nerve	9	5	4
Horizontal diameter of foramen for first spinal nerve	18	12	6
Distance from condylar articular surface to the bottom of the anterior notch of the transverse process	41	29	17
Distance from the bottom of the anterior notch of the transverse process to the anterior end of the vertebrarterial canal	35	42	38
Diameter of the vertebrarterial canal	7	8	4
Length of the vertebrarterial canal	44	21	10

[21] Numbers in italics indicate approximate measurements.

The Axis.

Five good specimens of the axis of *Moropus* were recovered, and fragments of others were found. Two of them, No. 1713, and the one belonging to the

FIG. 24. Lateral view of axis of *M. elatus* (No. 1604). × ⅓.

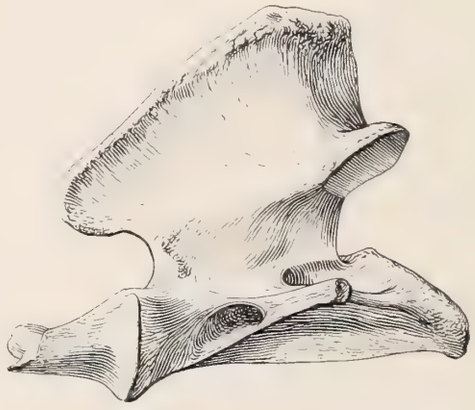


FIG. 25. Lateral view of axis of *M. petersoni* (No. 1703*A*). × ⅓.

mounted skeleton, No. 1604, are regarded by the writer as having possibly belonged to the cervical series of adults. No. 1703 is referred to *M. petersoni* and Nos. 1724 and 1725 belonged in all probability to young individuals of *M. elatus*.

The centrum is light, deeply excavated on both sides of the remarkably developed keel, which is a long, thin, vertical plate of bone expanding anteriorly

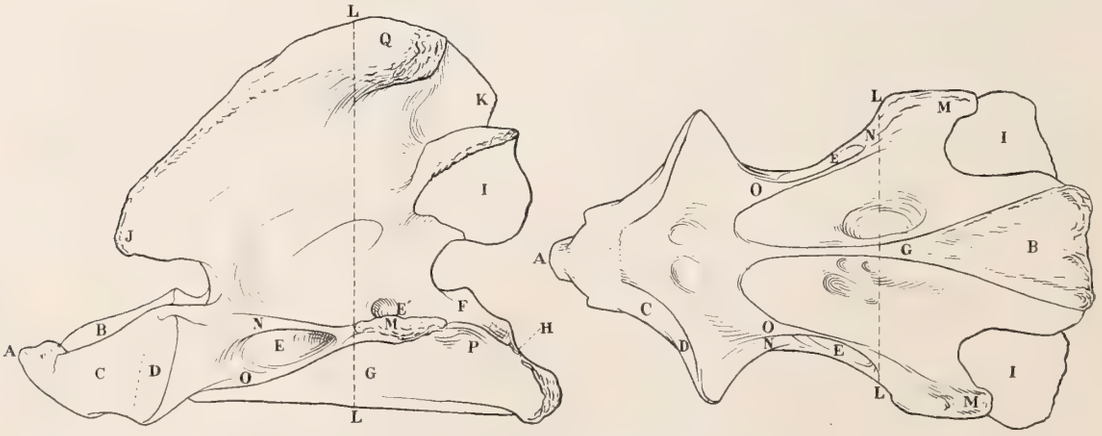


FIG. 26. Diagrammatic lateral and ventral view of axis of *M. elatus* (No. 1604). *A*, peglike projection of odontoid; *B*, spoutlike projection of odontoid; *C*, anterior articulating surface of odontoid fusing with *D*, anterior articulating face of centrum; *EE'*, vertebrarterial canal; *F*, fossa behind vertebrarterial canal; *G*, vertical keel of centrum; *H*, posterior face of centrum; *I*, articulating face of postzygapophyses; *J*, anterior overhanging extremity of neural spine; *K*, posterior extremity of neural spine; *LL*, dotted line showing place of section represented in Fig. 27; *M*, outer extremity of transverse process; *N*, upper lamella of transverse process; *O*, lower lamella of transverse process; *P*, lower lamella of t. p. behind; *Q*, enlarged lateral rugosity at top of spine.

and fusing with the body of the centrum behind the line of coössification with the odontoid process, and expanding still more posteriorly, fusing with and supporting the lower margin of the posterior articulating surface, which is cup-shaped and looks upward, the posterior margins being strongly produced backward. At the points where the keel terminates behind upon the lower margin of the cup are formed two elevated protuberances. While a keel-like ridge on the lower side of the centrum is not infrequently found in the axis of mammalia, the writer does not recall any case in which this feature is so strongly developed as it is in *Moropus*, though in the extinct genus *Trigonias* it is somewhat approximated. Among recent mammals in the genus *Equus*, and *Antilocapra*, there is a remarkable development of this ridge, though far from being what is seen in *Moropus*. The under side of the axis of *Moropus* recalls the structural features of the same bone found in some of the sauropod dinosaurs, with this marked difference that in the latter the keel has its lower edge reinforced by a bony plate below, so that in cross-section it has a ⊥-shaped outline. The accompanying diagram of a vertical section through the middle of the axis (Fig. 27) shows more clearly than can be done by mere description the structure of the centrum and the adjacent parts.

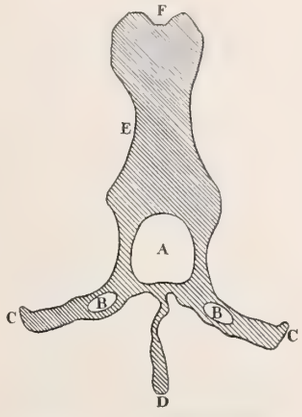


FIG. 27. Cross-section of axis of *M. elatus* (No. 1604). *A*, neural canal; *BB*, vertebrarterial canals; *CC*, transverse processes; *D*, vertical keel of centrum; *E*, neural spine; *F* sulcus on top of spine. ×⅓.

The lateral processes consist anteriorly of two broad lamellæ, arising behind the inner margin of the anterior articulating face one above and the other below the vertebrarterial foramen, which they form by their union externally. After uniting to enclose the vertebrarterial canal they flare outwardly and backwardly in a horizontal direction, forming the long thin extremity of the lateral process, which projects outwardly and backwardly, and is in specimens Nos. 1713 and 1725 thickened at the end, and is supported on the posterior portion of the centrum by a broad thin lamella of bone, a continuation of the lower lamina of the transverse process. This bony plate is deeply concave on its upper and convex on its lower surface, thus forming on its upper side a longitudinal groove or fossa in continuation of the lower wall of the vertebrarterial canal, the foramen of which immediately precedes this groove.

Between the lateral processes and the high central keel on the under side of the centrum are deep lateral cavities. Its outer margin and the projecting posterior

margin of the transverse process unite to form a deep lateral horizontal sinus between them.

The odontoid process is conical. Its transverse greatly exceeds its vertical diameter. It is relatively longer in the male than in the female. The faces for articulation with the atlas are concave horizontally and convex vertically, and unite to form continuous surfaces with the anterior articulating faces of the centrum, which have the same curvatures. Its anterior extremity shows a combination in

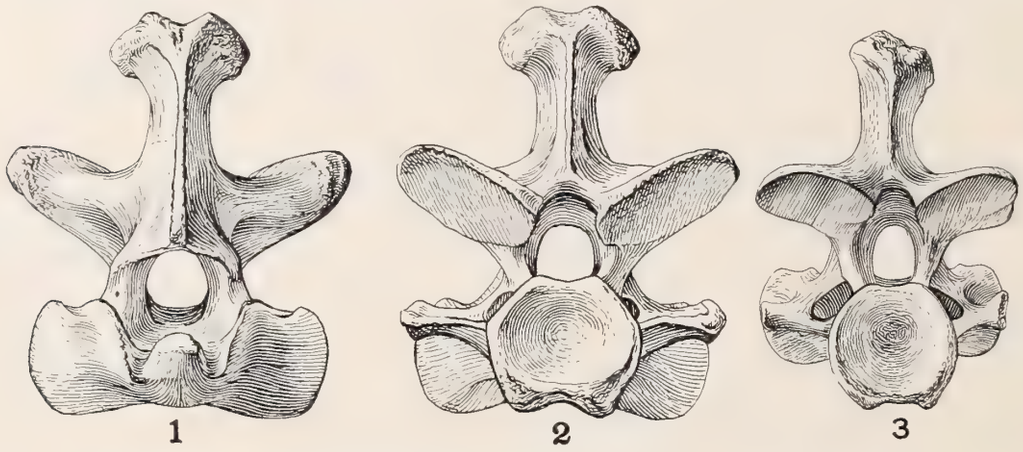


FIG. 28. 1, anterior view of axis of *M. elatus* (No. 1604), $\times\frac{1}{3}$; 2, posterior view of axis of *M. elatus* (No. 1604) $\times\frac{1}{3}$; 3, posterior view of axis of *M. petersoni* (No. 1703*A*), $\times\frac{1}{3}$.

structure of the "peg" and the "spout." The neural canal on the upper side of the odontoid divides into two grooves, semicircular in section on either side of the peg-like extremity of the bone, which points upward between these two grooves.

A deep notch for the second pair of spinal nerves occurs in front at the point of union of the pedicle with the centrum.

The spinous process is strongly developed antero-posteriorly, as well as vertically. It overhangs the odontoid in front. In the case of the specimens referred by me to the female sex the antero-posterior dimensions of the spine are markedly less in proportion to the rest of the bone than in specimens attributed to the male sex. At the back of the superior margin the spine is thickened in all cases, but much more in the two specimens, Nos. 1604 and 1713, which are regarded as having belonged to males. In the former of these the hinder margin of the spine swells out into more or less hemispherical masses on either side, and in specimen No. 1604 these lateral thickened masses are separated from each other above on the median line by a sulcus extending backward and gradually becoming deeper posteriorly.

The postzygapophyses are massive and look downwardly and outwardly. Their articulating faces are subrotund in most cases, though in No. 1604 they are somewhat oval, and at their outer extremities somewhat pointed.

Measurements of Axis.

	No. 1604, mm.	No. 1713, mm.	No. 1703, mm.	No. 1724, mm.	No. 1725, mm.
Greatest length between tip of odontoid and margin of centrum between perpendiculars	220	203	173	162	158
Height to top of neural spine	167	152	134	127	140
Length of centrum along under surface exclusive of odontoid process	148	138	126	112	108
Antero-posterior diameter of pedicel	90	88	77	73	75
Transverse diameter across posterior margins of prezygapophyses	120	113	90	108	98
Transverse diameter across postzygapophyses	140	120	100	115	98
Transverse diameter of vertebra across ends of transverse processes	130	110	97	105	96
Transverse diameter of articular faces of postzygapophyses	65	57	45	50	48
Vertical diameter of neural canal	30	25	25	30	24
Transverse diameter of neural canal	25	20	13	20	20
Length of odontoid process	72	65	47	50	50
Transverse diameter of neural canal at base of odontoid process	45	35	35	35	35
Vertical diameter of odontoid process from floor of neural canal	18	18	10	20	20
Transverse diameter of peg-like projection	20	17	7	15	15
Vertical diameter of peg-like projection	24	20	11	15	14
Horizontal diameter of peg-like projection	25	25	17	20	20
Horizontal diameter of articulating face of "spout" at middle	65	60	50	50	43
Vertical diameter of articulating face of "spout" at middle	33	35	23	35	35
Transverse diameter of posterior face of centrum	65	60	49	53	45
Supero-inferior diameter of posterior face of centrum	70	65	50	50	50
Vertical height of posterior face of centrum measured perpendicularly	54	48	38	38	42
Height of keel of centrum at middle	40	32	20	22	20
Distance to floor of neural canal from bottom of keel at middle	45	43	35	37	42
Transverse diameter of neural spine in front	5	5	5	5	5
Transverse diameter of neural spine above origin of postzygapophyses	63	30	30	30	30
Antero-posterior diameter of neural spine at top	165	165	130	136	140

The Third Cervical Vertebra.

The third cervical vertebra of specimen 1604 is well preserved. Six other third cervicals were recovered in a more or less imperfect condition.

The prezygapophyses, which look inward and upward, are slightly convex upon their faces. The postzygapophyses, which look downward and outward, are very slightly concave transversely and convexo-concave from above downward, the concave portion of the surface being a narrow depressed transverse groove situated at the lower margin of the articular face, below which the outer surface

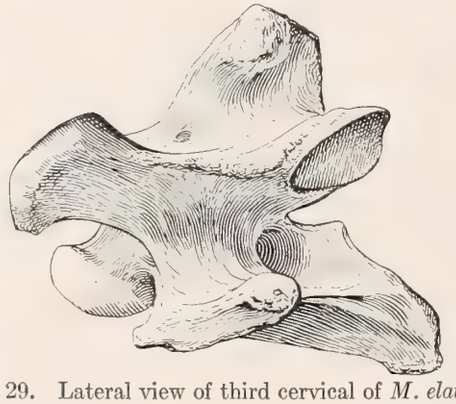


FIG. 29. Lateral view of third cervical of *M. elatus* (No. 1604). ×⅓.

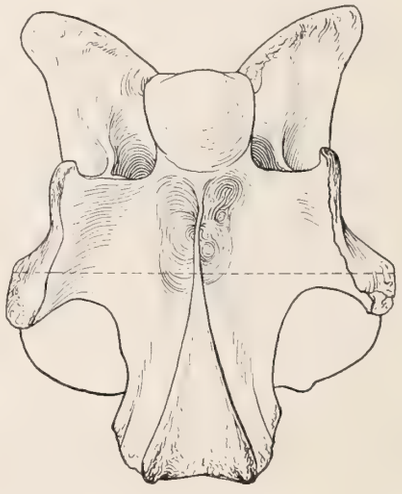


FIG. 30. Outline view of inferior surface of third cervical of *M. elatus* (No. 1604). Dotted line shows point of section shown in Fig. 32. ×⅓.

of the bone forms a slightly raised marginal rim. The neural canal is large. The dorsal spine is well developed and greatly enlarged at its extremity by bulbous outgrowths on either side, which are, however, not so large and heavy as on the spine of the axis. The anterior articular surface of the centrum is hemispherical and looks downward, fitting thus into the corresponding articular surface of the axis, which, as has been already pointed out, projects strongly backward. The structure of the centrum corresponds to that of the atlas. The lower wall of the neural canal is quite thin, supported below by a high thin keel, which, arising immediately behind the anterior articulating surface of the centrum, gradually widens and thickens posteriorly until it melts into the posterior margins of the cup-shaped posterior articulating face, at its termination on both sides giving rise to two tubercular prominences.

The transverse processes, which are very strongly developed, are formed as in the atlas by the union of upper and lower laminæ between which at their origin

is located the vertebrarterial canal, which is large and oval in cross-section. The outward extremity of the transverse processes is enlarged, somewhat truncate, and rolled downward like a scroll with the anterior tubercle pointing forward and downward and the heavier posterior tubercle pointing outward and upward.

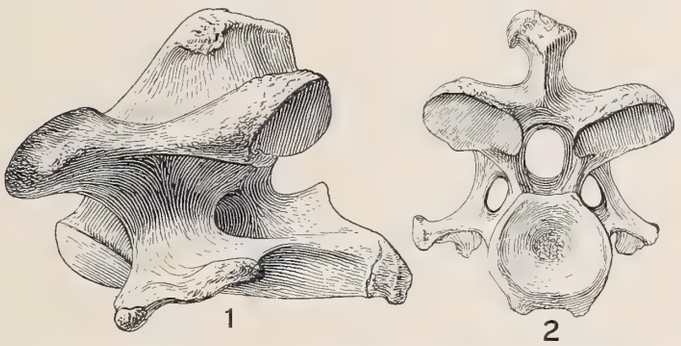


FIG. 31. Third cervical of *M. petersoni* (1703*A*). 1, lateral view; 2, posterior view. $\times\frac{1}{3}$.

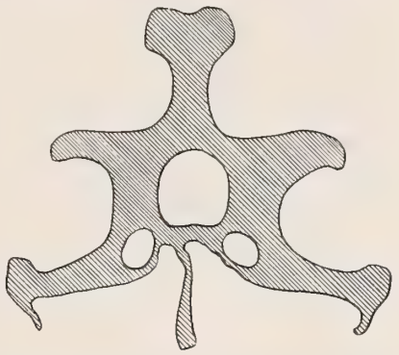


FIG. 32. Cross-section of third cervical vertebra of *M. elatus* (No. 1604). $\times\frac{1}{3}$.

The lower margin of the vertebrarterial canal is continuous with a deep fossa on the upper side of the lower lamina of the transverse process, which is continued backward as an upwardly bent scroll-shaped projection until it fuses with the margin of the posterior articulating face of the centrum about its middle. A cross-section of the bone is given in Figure 32.

MEASUREMENTS OF THIRD CERVICAL VERTEBRA.

	No. 1604, mm.
Greatest length from front margin of prezygapophyses to hind margin below between perpendiculars	190
Height to top of neural spine	155
Length of centrum along the under surface	165
Antero-posterior diameter of pedicel	80
Diameter measured across face of prezygapophyses	138
Distance between articulating faces of prezygapophyses above	25
Diameter measured across face of postzygapophyses	152
Distance between articulating faces of postzygapophyses in front	40
Distance between articulating faces of postzygapophyses behind	26
Diameter across anterior extremities of transverse processes	112
Diameter across posterior extremities of transverse processes	165
Transverse diameter of articular faces of prezygapophyses	60
Supero-inferior diameter of articular faces of prezygapophyses	50
Transverse diameter of articular faces of postzygapophyses	60
Supero-inferior diameter of articular faces of postzygapophyses	65
Vertical diameter of neural canal	35
Transverse diameter of neural canal	30

Antero-posterior diameter of anterior articulating surface of centrum	50
Transverse diameter of anterior articulating surface of centrum	45
Transverse diameter of posterior face of centrum	65
Supero-inferior diameter of posterior face of centrum	70
Vertical height of posterior end of centrum measured perpendicularly	50
Greatest height of keel of centrum below transverse processes	35
Distance to neural canal from bottom of keel of centrum at middle	45
Transverse diameter of neural spine in front	1
Transverse diameter of neural spine above origin of postzygapophyses	40
Antero-posterior diameter of spine at origin	80
Antero-posterior diameter of spine at upper extremity	43
Height of spine from origin	45
Antero-posterior diameter of outer margin of transverse processes	75
Transverse diameter of vertebrarterial canal	8
Supero-inferior diameter of vertebrarterial canal	15

The Fourth Cervical Vertebra.

The fourth cervical vertebra of specimen No. 1604 is excellently preserved. It closely resembles in its general structure the third cervical, but is broader transversely. The anterior and posterior tubercles of the transverse processes are heavier and tend to assume a more vertical position in relation to each other than

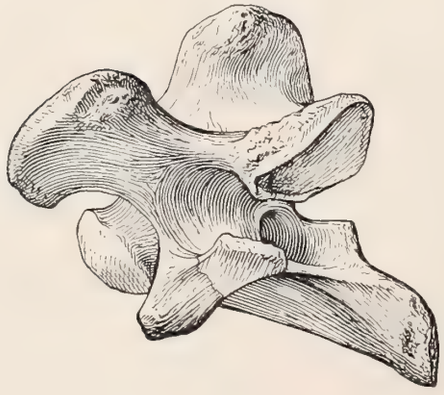


FIG. 33. Lateral view of fourth cervical of *M. elatus* (No. 1604). $\times\frac{1}{3}$.

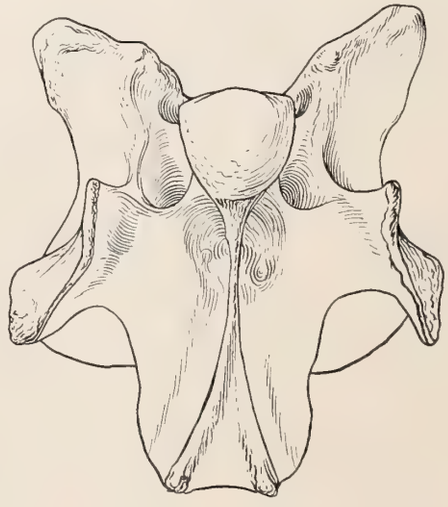


FIG. 34. Ventral view of fourth cervical of *M. elatus* (No. 1604). $\times\frac{1}{3}$

is the case in the third cervical. The horizontal marginal sinus back of the transverse process is not as deep as in the preceding vertebra, and the neural spine is not as heavy on its upper margin. The protuberances on the lower margin of the posterior articulating face of the centrum marking the lateral boundaries of the widening keel are much enlarged and prominent.

Measurements of Fourth Cervical Vertebra.

	No. 1604, mm.
Greatest length from front margin of prezygapophyses to hind margin below between perpendiculars	195
Height to top of neural spine	147
Length of centrum along the under surface	165
Antero-posterior diameter of pedicel	75
Diameter across face of prezygapophyses	158
Distance between faces of prezygapophyses above	32
Diameter across face of postzygapophyses	170
Distance between faces of postzygapophyses in front	55
Distance between faces of postzygapophyses behind	38
Diameter across anterior extremities of transverse processes	120
Diameter across posterior extremities of transverse processes	180
Transverse diameter of articular faces of prezygapophyses	65
Supero-inferior diameter of articular faces of prezygapophyses	70
Transverse diameter of articular faces of postzygapophyses	70
Supero-inferior diameter of articular faces of postzygapophyses	63
Vertical diameter of neural canal	30
Transverse diameter of neural canal	30
Antero-posterior diameter of anterior articulating face of centrum	50
Transverse diameter of anterior articulating face of centrum	45
Transverse diameter of posterior articulating face of centrum	65
Vertical height of posterior end of centrum measured perpendicularly	50
Greatest height of keel of centrum below transverse process	30
Distance of neural canal from bottom of keel at middle	45
Transverse diameter of neural spine in front	3
Transverse diameter of neural spine at origin of postzygapophyses	30
Antero-posterior diameter of spine at origin	65
Antero-posterior diameter of spine at upper extremity	40
Height of spine from origin	45
Antero-posterior diameter of outer margin of transverse process	70
Transverse diameter of vertebrarterial canal	10
Supero-inferior diameter of vertebrarterial canal	20

The Fifth Cervical Vertebra.

The fifth cervical vertebra is well preserved in specimen No. 1604. In its general features it resembles its immediate predecessor. The transverse processes at their outer extremities increase in size, and the anterior tubercle becomes a broad thin process pointing downward and inward, while the posterior tubercle is a heavy process, subtriangular in section, extending outward and backward, strongly roughened at the end to provide muscular attachments. The posterior horizontal marginal sinus is shallower than in the fourth cervical. The neural spine is not quite as heavy as in the fourth cervical, and the keel of the centrum

is not as high, but the lateral prominences below the lower margin of the posterior articulating face of the centrum are more strongly developed.

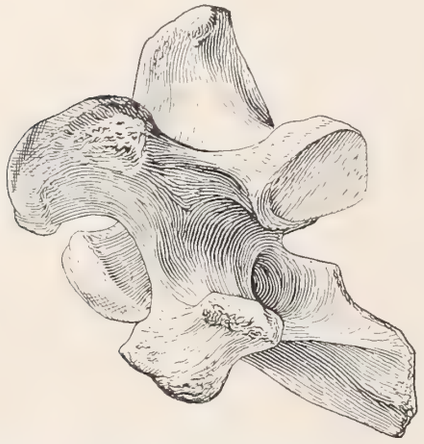


FIG. 35. Lateral view of fifth cervical of *M. elatus* (No. 1604). $\times\frac{1}{3}$.

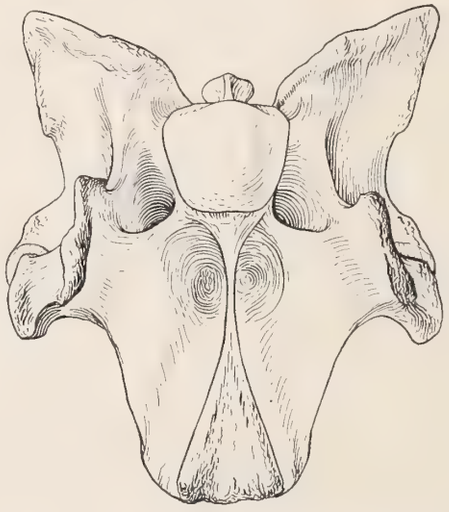


FIG. 36. Ventral view of fifth cervical of *M. elatus* (No. 1604). $\times\frac{1}{3}$.

MEASUREMENTS OF FIFTH CERVICAL VERTEBRA.

	No. 1604, mm.
Greatest length from front margin of prezygapophyses to hind margin below measured between perpendiculars	197
Height to top of neural spine	160
Length of centrum along under surface	160
Antero-posterior diameter of pedicel	75
Diameter across face of prezygapophyses	170
Distance between faces of prezygapophyses above	43
Diameter across postzygapophyses	175
Distance between faces of postzygapophyses in front	55
Distance between postzygapophyses behind	37
Diameter across anterior extremities of transverse processes	120
Diameter across posterior extremities of transverse processes	175
Transverse diameter of articular faces of prezygapophyses	70
Supero-inferior diameter of articular faces of prezygapophyses	66
Transverse diameter of articular faces of postzygapophyses	80
Supero-inferior diameter of articular faces of postzygapophyses	55
Vertical diameter of neural canal	30
Transverse diameter of neural canal	30
Antero-posterior diameter of anterior articulating face of centrum	50
Transverse diameter of anterior articulating face of centrum	50
Transverse diameter of posterior articulating face of centrum	65
Supero-inferior diameter of posterior articulating face of centrum	70

Vertical height of posterior end of centrum measured perpendicularly	55
Greatest height of keel of centrum below transverse processes	27
Distance to neural canal from bottom of keel of centrum at middle	45
Transverse diameter of neural spine in front	1
Transverse diameter of neural spine above origin of postzygapophyses	27
Antero-posterior diameter of spine at origin	42
Antero-posterior diameter of spine at upper extremity	35
Height of spine from origin	60
Antero-posterior diameter of outer margin of transverse process	70
Transverse diameter of vertebrarterial canal	10
Supero-inferior diameter of vertebrarterial canal	20

The Sixth Cervical Vertebra.

On comparing the sixth cervical with the fifth we detect a profound modification of the lower surface of the centrum and the transverse processes in the former, which also becomes much shorter in some of its antero-posterior dimensions.

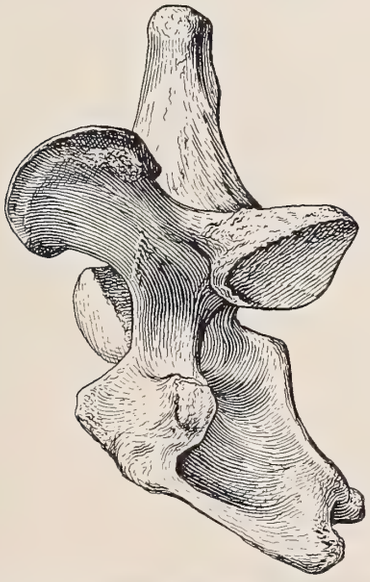


FIG. 37. Lateral view of sixth cervical of *M. elatus* (No. 1604). $\times\frac{1}{3}$.

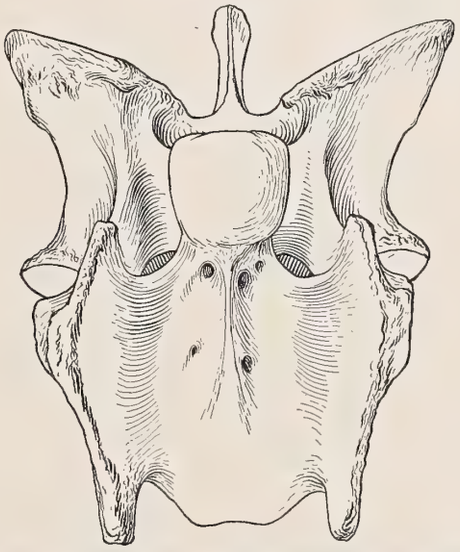


FIG. 38. Ventral view of sixth cervical of *M. elatus* (No. 1604). $\times\frac{1}{3}$.

The long thin keel of the centrum, which is so characteristic a feature of cervicals 2–5 is very greatly reduced in the sixth and becomes a low broad ridge not more than five millimeters in height. The posterior part of the inferior lamina of the transverse process which in the preceding vertebrae is shown to carry upon its superior surface a fossa in continuation of the vertebrarterial canal widens out laterally and downwardly and fuses with the main body of the transverse process in front in such a way as to wholly obliterate the horizontal posterior marginal

sinus, the outer inferior margin of the lamina forming an almost straight marginal line from the posterior tubercle. Moreover this lamina is greatly produced backwards at its posterior angle beyond the lower margin of the centrum in such a way as to leave a deep notch between it and the inferior lip of the posterior articulating surface of the centrum. The vertebrarterial foramen is greatly enlarged in diameter, while the portion of the upper lamina, which protects it externally, is much reduced in its antero-posterior diameter. Just behind the posterior tubercle of the transverse process on the upper surface of the posterior lamina is a deep cavity or oval fossa. The neural spine is higher and narrower both transversely and antero-posteriorly.

Measurements of Sixth Cervical Vertebra.

	No. 1604, mm.
Greatest length from front margin of prezygapophyses to hind margin below measured between perpendiculars	197
Height to top of neural spine	187
Length of centrum along under surface	160
Antero-posterior diameter of pedicel	55
Diameter across face of prezygapophyses	182
Distance between faces of prezygapophyses above	42
Diameter across postzygapophyses	165
Distance between faces of postzygapophyses in front	65
Distance between postzygapophyses behind	45
Diameter across anterior extremities of transverse processes	115
Diameter across posterior extremities of transverse processes	157
Transverse diameter of articular faces of prezygapophyses	75
Supero-inferior diameter of articular faces of prezygapophyses	60
Transverse diameter of articular faces of postzygapophyses	63
Supero-inferior diameter of articular faces of postzygapophyses	60
Vertical diameter of neural canal	30
Transverse diameter of neural canal	35
Antero-posterior diameter of anterior articulating face of centrum	52
Transverse diameter of anterior articulating face of centrum	50
Transverse diameter of posterior articulating face of centrum	68
Supero-inferior diameter of posterior articulating face of centrum	80
Vertical height of posterior end of centrum measured perpendicularly	50
Greatest height of keel of centrum below transverse processes	6
Distance of neural canal from bottom of keel of centrum at middle	45
Transverse diameter of neural spine in front	1
Transverse diameter of neural spine above origin of postzygapophyses	15
Antero-posterior diameter of spine at origin	50
Antero-posterior diameter of spine at upper extremity	25
Height of spine from origin	80
Antero-posterior diameter of outer margin of transverse process	70

Transverse diameter of vertebrarterial canal..... 15
Supero-inferior diameter of vertebrarterial canal..... 27

The Seventh Cervical Vertebra.

In the seventh cervical vertebra a still more profound change in structure than has been observed in the sixth takes place. The vertebrarterial canal wholly

FIG. 39. Lateral view of seventh cervical of *M. elatus* (No. 1604). $\times\frac{1}{3}$.

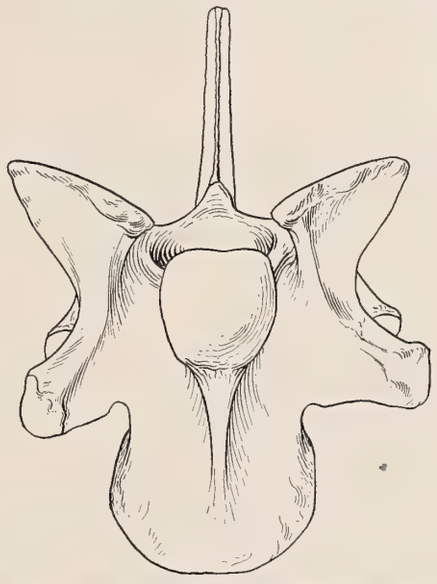


FIG. 40. Ventral view of seventh cervical of *M. elatus* (No. 1604). $\times\frac{1}{3}$.

disappears. The transverse process becomes a solid bony mass, subtriangular in cross-section, elongated, and pointing downward and outward. The posterior

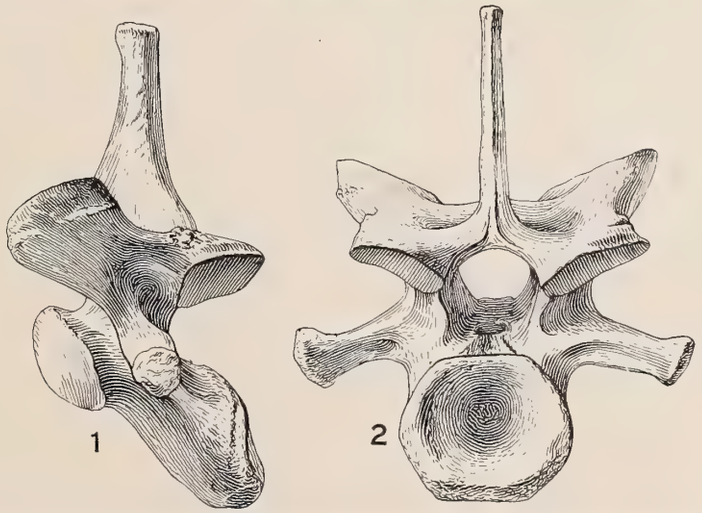


FIG. 41. 1, lateral view of seventh cervical of *M. petersoni* (No. 1703*A*); 2, posterior view of do. $\times\frac{1}{3}$.

part of the inferior lamina of the transverse process, by which it is in the preceding vertebræ attached to the centrum behind becomes obsolete, or at most only vestiges of it remain as a thin wing of bone on the back of the lower margin of the transverse process. The anterior and posterior tubercles of the transverse process are so fused together as to become indistinguishable from each other, and combine at the outer extremity of the transverse process to form a somewhat reflexed rounded termination. The keel of the centrum almost wholly disappears. The neural spine is long, slender, pointed, and lies in almost the same plane as the posterior articulating face of the centrum. All of the antero-posterior and most of the transverse dimensions of the bone, except those of the anterior and posterior articulating faces of the centrum, are greatly reduced.

Measurements of Seventh Cervical Vertebra.

	No. 1604, mm.
Greatest length from front margin of prezygapophyses to hind margin below measured between perpendiculars	174
Height to top of neural spine	142
Length of centrum along under surface	132
Antero-posterior diameter of pedicel	42
Diameter across face of prezygapophyses	160
Distance between faces of prezygapophyses above	48
Diameter across postzygapophyses	143
Distance between faces of postzygapophyses in front	52
Distance between postzygapophyses behind	45
Diameter across extremities of transverse processes	175
Transverse diameter of articular faces of prezygapophyses	60
Supero-inferior diameter of articular faces of prezygapophyses	55
Transverse diameter of articular faces of postzygapophyses	50
Supero-inferior diameter of articular faces of postzygapophyses	45
Vertical diameter of neural canal	35
Transverse diameter of neural canal	45
Antero-posterior diameter of anterior articulating face of centrum	50
Transverse diameter of anterior articulating face of centrum	50
Transverse diameter of posterior articulating face of centrum	85
Supero-inferior diameter of posterior articulating face of centrum	80
Vertical height of posterior end of centrum measured perpendicularly	45
Distance of neural canal from bottom of centrum at middle	37
Transverse diameter of neural spine in front	2
Transverse diameter of neural spine above over origin of postzygapophyses	10
Antero-posterior diameter of spine at origin	45
Antero-posterior diameter of spine at upper extremity	15
Height of spine from origin	120
Antero-posterior diameter of outer margin of transverse process	30

The Dorsal Vertebræ.[22]

The dorsal vertebræ of specimen No. 1604 were all found in a more or less perfect condition with the exception of the eighth and the eleventh. These have been restored in the light of other specimens belonging to other individuals and by accurate comparison with the vertebræ immediately preceding and succeeding them. More or less imperfect series of dorsal vertebræ belonging to other individuals were discovered, and these have been arranged in series for purposes of study.

Catalog No. 1703B.

This series consists of the first four dorsals, the first and second of which have lost the posterior epiphyses of the centra, the last two of which, although they have sustained a few minor injuries, have preserved both the anterior and the posterior epiphyses.

Catalog No. 1703C.

This series consists of the seventh, tenth, eleventh, twelfth, thirteenth, and fourteenth dorsals of a small but mature individual. The epiphyses on all the centra are well preserved and there is every evidence of the maturity of the animal. These bones are referred, together with other bones placed under the general accession number 1703, to the species named by the writer *Moropus petersoni.*

Catalog No. 1708.

Consists of the more or less imperfect centra of dorsals eleven, twelve, and fifteen. These specimens were found with the lumbars of the same series and bearing

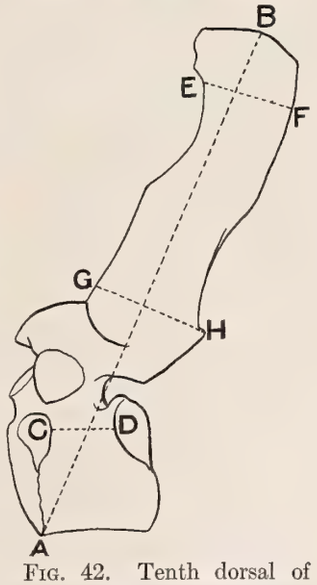


FIG. 42. Tenth dorsal of *Moropus elatus* (No. 1604). Diagram to show the manner of taking measurements followed by the author.

[22] In measuring the dorsal vertebræ it should be explained that in ascertaining the greatest height a line from the anterior lower margin of the centrum to the top of the spine has in all cases been employed, as shown in the accompanying diagram *A–B*. The distance between the heads of ribs is measured on the side of the centrum from *C–D*. In all cases the greatest measurement is taken, even when this is not expressed in the tables. The only exception is in the measurement of the antero-posterior diameter of the spine; in taking which a point has been selected in each case just below the tubercular enlargement, *E–F*. The height of the spine from the neural canal to the top is measured always along the anterior face of the spine. The anteroposterior diameter of the spine above the neural canal is measured on the line *G–H*. In measuring the transverse diameter of the anterior face of the centrum a line just below the anterior faces for the heads of the ribs has been used, as this marks the widest point. The transverse measurement of the posterior face of the centrum always includes the faces for the heads of the ribs.

the same accession number and evidently belonged to a large and fully matured specimen of *Moropus elatus* Marsh.

Catalog No. 1712.

This is a remarkably well preserveds series, representing the first five dorsals belonging to an animal of considerable size. The bones articulate very well, and

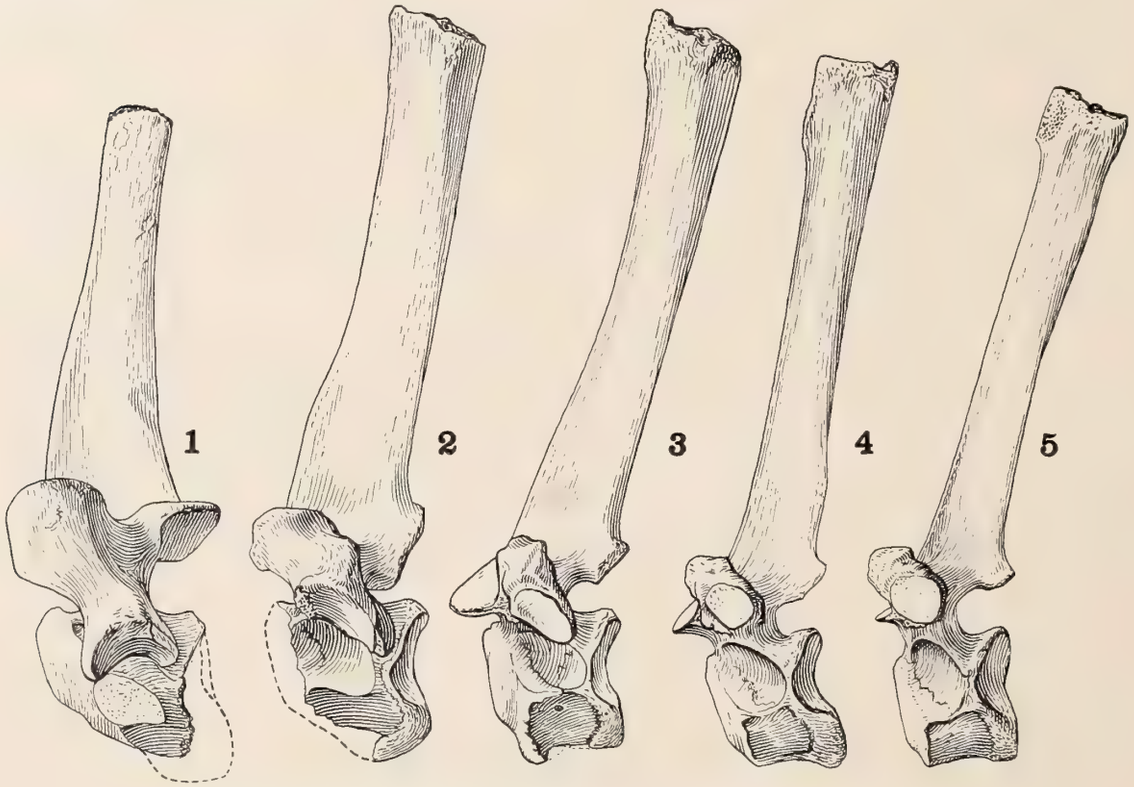


FIG. 43. Lateral view of the first five dorsals (No. 1712, C. M. Cat. Vert. Foss.). $\times\frac{1}{3}$.

with the exception of minor injuries at the extremity of the spines and of the articulating faces between 1 and 2 are practically perfect.

Catalog No. 1713.

This series consists of the second, fifth, sixth, seventh, tenth, twelfth, fourteenth, and fifteenth dorsals of a large and somewhat immature individual. In all cases the posterior epiphyses of the centra have been lost and in the case of the sixth and the fourteenth the anterior epiphysis has also been lost. The spines and transverse processes in this series are upon the whole very well preserved.

Catalog No. 1714.

In this series dorsals two, six, seven, and nine are represented. They belonged to a somewhat immature specimen of small size, the posterior epiphyses in all cases being wanting and the anterior epiphysis in the sixth vertebra having also slipped.

Catalog No. 1715.

This consists of dorsals four, five, six, the spine of dorsal seven, and dorsals twelve and fifteen. With the exception of dorsals five, twelve, and fifteen the specimens are somewhat injured. They represent a mature individual of small size, undoubtedly belonging to *Moropus petersoni*.

Catalog No. 1716.

Consists of the second dorsal of an individual of medium size.

Catalog No. 1717.

This is the second dorsal vertebra of a young individual of small size, the spine and transverse processes being well preserved but both the anterior and posterior epiphyses of the centrum having been lost.

Catalog No. 1718.

This is a somewhat injured specimen of the first dorsal of a young individual of medium size which has lost the anterior and posterior epiphyses of the centrum.

Catalog No. 1719.

This is a remarkably well preserved first dorsal of a medium sized individual, which has sustained no injury whatever.

Catalog No. 1731.

Consists of the centra of dorsals eight, nine, and ten. The centra are well preserved and represent a large and mature individual. The neural arches and the spines have, however, been completely lost from these three specimens.

The First Dorsal Vertebra.

This vertebra is represented in the collection by five specimens. In the mounted specimen, No. 1604, unfortunately only the centrum of this bone remained and that in a damaged condition, but showing enough to enable its antero-posterior diameter to be ascertained. The specimens catalogued as Nos. 1703*B*, 1712, 1718, and 1719 supplied the outline of the missing portions, although all are smaller than

No. 1604. Mr. Peterson was enabled by the help of this material to reconstruct the vertebræ for the mounted specimen in such a manner that no doubt as to its true form exists. In No. 1703*B* the neural spine, the lateral processes, the prezygapophyses, postzygapophyses, and the walls of the neural canal are well preserved, though the lower portion of the centrum is somewhat damaged. Specimen No. 1712 more nearly approximates No. 1604 in size than any other specimen, and preserves all the articulating surfaces except the posterior articulating surface of the centrum, from which the epiphysis has been lost. No. 1718 is in nearly the same condition as number 1712. Specimen No. 1719 (see Fig. 44, 1–4) is the best

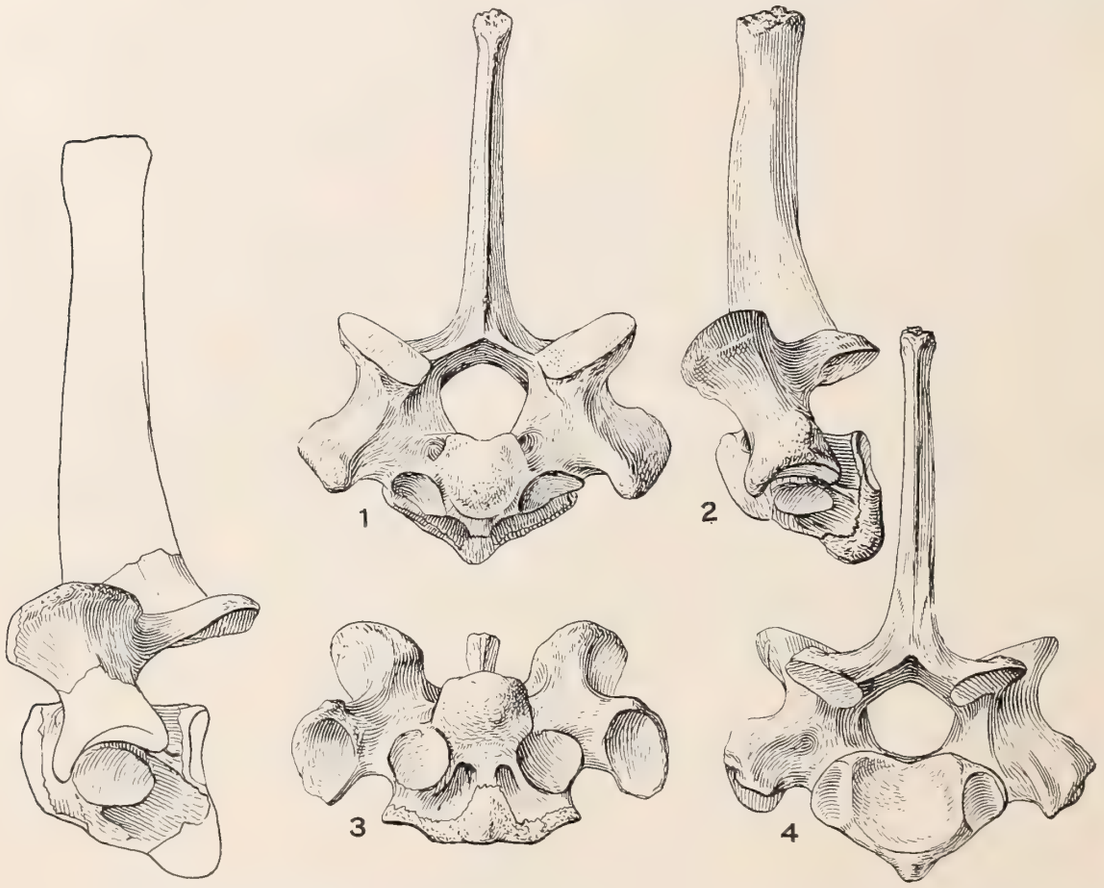


Fig. 44. Remnant of first dorsal of *M. elatus* (No. 1604), ×⅓. 1, first dorsal (No. 1719), anterior view; 2, do., lateral view; 3, do., inferior view; 4, do., posterior view. ×⅓.

preserved of all the first dorsals, but has, like all others mentioned, lost the posterior epiphysis of the centrum. Though lacking this surface, the form of the anterior articular surface of the second dorsal, which is well preserved in a number of specimens, permits the reconstruction of the missing posterior face of the centrum of the first dorsal.

A comparison of the four specimens which have been mentioned in the preceding paragraph makes possible an exact description of the bone.

The neural spine is elevated, slender, and slightly recurved. This backward curvature is most noticeable in specimens 1703*B* and 1718, which are referred to *M. petersoni*. The antero-posterior diameter of the spine at the tip is much less than at its origin, this being especially noticeable in specimen No. 1712, in which the neural spine is fully twice as deep at its origin as at its extremity. The prezygapophyses are elevated and oblique for articulation with the last cervical. In specimen No. 1703*B* the articulating surface of the prezygapophyses is rotund; in the others the surface is more or less oval. The prezygapophyses are much further apart than the postzygapophyses, and look upward, inward and forward; while the postzygapophyses look downward and outward. The pedicels of the first dorsal stand mostly on the anterior half of the centrum and their transverse diameter is nearly twice that of their antero-posterior diameter at the middle. The neural canal is semi-circular in outline below, but above, owing to the depression of the laminæ, it is pointed, as shown in Fig. 44, 4. The diameter of the centrum is greater transversely than vertically. Its anterior articulating surface, which is well preserved in specimens Nos. 1712, 1718, and 1719, looks forward and downward. It is somewhat cordate in outline. On the lower side of the centrum at the middle is a triangular process of the bone the base of which clasps the posterior margin of the anterior epiphysis, and the apex of which is produced backward as a slightly elevated keel. On either side on the centrum, just behind the anterior epiphysis, is a circular digital depression for the accommodation for the capitulum of the first rib. Immediately in advance of each of these depressions on each side is a deep pit, at the bottom of which is a small nutrient foramen. The outer extremity of the transverse process is strongly tubercular and deeply excavated, furnishing a broad concave articulating surface for the accommodation of the tuberculum of the first rib. This surface looks downward and forward.

The posterior articulating surface of the centrum, as has already been stated, is in all of the specimens more or less mutilated through the loss of the epiphysis, but undoubtedly, in addition to a concave depression in the center to accommodate the anterior articulating surface of the succeeding vertebra, there was on either side a facet to accommodate the anterior surface of the capitulum of the second rib. The centrum in cross-section at the middle is subtriangular in outline.

Measurements of First Dorsal Vertebra.[23]

	1604, mm.	1703*B*, mm.	1712, mm.	1718, mm.	1719, mm.
Greatest height from base of centrum to top of spine	*295*	*181*	260	210	212
Greatest transverse diameter measured across transverse processes	*190*	150	177	*145*	152
Greatest antero-posterior diameter measured from front of prezygapophyses to back of postzygapophyses	*110*	72	97	68	83
Length of centrum along floor of neural canal	*50*	*38*	*47*	*32*	*43*
Length of centrum along inferior surface	45	*28*	*30*	*30*	*28*
Vertical diameter of anterior face of centrum	75	*42*	62	45	40
Vertical diameter of posterior face of centrum	*70*	*40*	*58*	*38*	*40*
Vertical diameter of neural canal	*30*	25	33	38	34
Antero-posterior diameter of prezygapophyses	*55*	35	40	36	38
Transverse diameter of prezygapophyses	*48*	35	52	40	47
Distance across prezygapophyses	*140*	115	138	116	122
Antero-posterior diameter of postzygapophyses	*40*	20	30–35	37	23
Transverse diameter of postzygapophyses	*40*	30	40	35	33
Distance across postzygapophyses	*112*	85	107	95	97
Transverse diameter of anterior face for head of rib	*30*	20	30	20	27
Antero-posterior diameter of anterior face for head of rib	*30*	22	30	20	26
Vertical diameter of posterior face for head of rib	*40*	..	..	..	..
Horizontal diameter of posterior face for head of rib	*27*	..	..	..	..
Antero-posterior diameter of face for tubercle of rib	*40*	20	35	30	35
Transverse diameter of face for tubercle of rib	*34*	25	30	30	28
Transverse diameter of pedicel	*45*	33	45	38	40
Antero-posterior diameter of pedicel at narrowest point	*15*	16	15	14	15
Distance between faces for heads of ribs	*25*	...	...	12	12
Height of spine from neural canal to extremity	*203*	135	175	140	144
Antero-posterior diameter of spine above neural canal	*57*	33	61	36	38
Antero-posterior diameter of spine at top	*32*	25	28	19	25

The Second Dorsal Vertebra.

The Agate Spring Fossil Quarry yielded seven more or less complete specimens of the second dorsal of *Moropus*. These are numbered in the Catalogue of Vertebrate Fossils in the Carnegie Museum as specimens 1604, 1703*B*, 1712, 1713, 1714, 1716, and 1717. Of these numbers 1716 (see Figs. 45 and 46) is a perfect specimen, showing all the articulating surfaces. No. 1712 is complete except for the loss of the anterior epiphysis of the centrum, which is present in all the other specimens except 1717, from which it has likewise departed. All the other specimens except 1604 have lost the posterior epiphysis, a sign of immaturity. Of No. 1604, the mounted specimen, the centrum with its transverse processes and the lower third of the spine is preserved. The upper part of the spine has been

[23] All measurements in italics approximate, specimens being restored, or broken.

restored by Mr. Peterson. The possession of these seven specimens permits an accurate description of this member of the vertebral series.

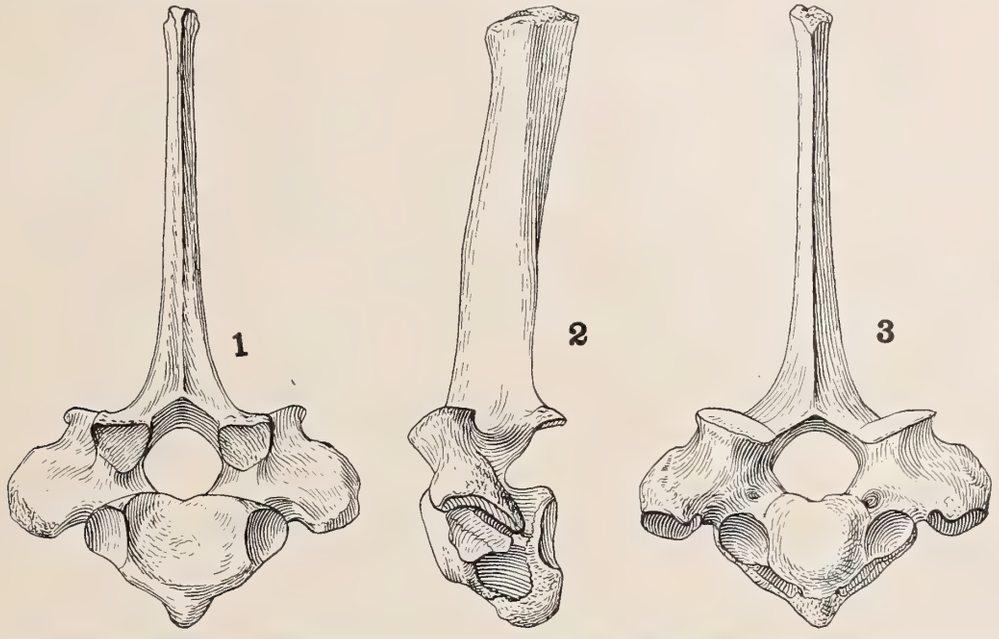


Fig. 45. Second dorsal of *Moropus* (No. 1716, C. M. Cat. Vert. Foss.). ×⅓. 1, posterior view; 2, lateral view; 3, anterior view.

The spine is longer than in the first dorsal, and viewed laterally tapers at the top, with the exception of specimens 1713 and 1716, which are widened and flattened out at their upper ends. No. 1713 gives evidence of having received injury during the life of the animal to which it belonged. The postzygapophyses are malformed and the spine is twisted to the left. The spine in all specimens is triangular in horizontal section near its origin, with the base of the triangle behind, and the apex pointing forward. Above the middle it becomes oblong-oval in cross-section. The transverse processes are smaller and the articulating faces of the prezygapophyses and the postzygapophyses are much smaller than in the first dorsal. The prezygapophyses are oblique, transversely oblong, and look upward and inward; the postzygapophyses are subtriangular or rudely oval and look backward and downward. The anterior articulating face of the centrum looks forward and somewhat downward; the posterior articulating face is almost vertical, looking back and very little, if at all, upward. The epiphysis in front,

Fig. 46. Inferior view of second dorsal of *Moropus* (No. 1716, C. M. Cat. Vert. Foss.). ×⅓.

as shown by No. 1716, at the middle of the lower part of the centrum throws backward a process, which fuses on the median line with a similar but more massive process thrown forward by the posterior epiphysis. These projections unite to clasp the body of the centrum below and create on the median line a short keel-like projection or prominence. (Fig. 46.) The pedicels rest mainly on the anterior half of the centrum and show before and behind well-marked grooves at the point of exit of the nerve. The anterior facets for the head of the rib are concave, suboval in some specimens, in others more nearly round in outline. In advance of these facets on either side of the anterior epiphysis near its upper margin is a small nutrient foramen. The posterior articular facets for the head of the rib are concave and subtriangular in outline, with the angles rounded, having the longest side next to the posterior articulating surface of the centrum which receives the following rib. They are located at the point of union of the transverse process with the body of the centrum and fuse with the outer margins of the posterior epiphysis, as is beautifully shown by specimen No. 1716. The accompanying cuts (Figs. 45 and 46) illustrate the facts better than can be done by a description. The articular surface for the tubercle of the rib looks downward and forward. The orifice of the neural canal shows some variation in outline in the different specimens. In the smaller and less mature specimens the opening is nearly circular. In No. 1713, and noticeably in No. 1604, it is transversely oval.

FIG. 47. Second dorsal of *M. elatus* (No. 1604). ×⅓.

MEASUREMENTS[24] OF SECOND DORSAL VERTEBRA.

	1604, mm.	1703*B*, mm.	1712, mm.	1713, mm.	1714, mm.	1716, mm.	1717, mm.
Greatest height from base of centrum to top of spine	*314*	230	307	275	204	248	183
Greatest transverse diameter, measured across transverse processes	172	140	155	*156*	120	141	104
Greatest antero-posterior diameter, measured from front of prezygapophyses to back of postzygapophyses	*90*	64	72	76	60	65	51
Length of centrum along floor of neural canal	50	*40*	48	*42*	*34*	42	28

[24] Numbers in italics show that the measurement is approximate only, the specimen being broken.

Length of centrum along inferior surface	43	*30*	40	*35*	*23*	30	17
Vertical diameter of anterior face of centrum	62	40	68	50	35	40	35
Transverse diameter of anterior face of centrum	45	35	40	45	30	38	33
Vertical diameter of posterior face of centrum including faces for head of ribs	65	*40*	60	*47*	*40*	40	38
Transverse diameter of posterior face of centrum	102	*77*	100	*95*	*80*	83	*75*
Vertical diameter of neural canal	25	30	33	28	25	28	23
Transverse diameter of neural canal	39	35	35	35	25	33	22
Antero-posterior diameter of prezygapophyses	*38*	20	26	20	18	20	17
Transverse diameter of prezygapophyses	*37*	30	40	35–38	29	32	24
Distance across prezygapophyses	*104*	95	111	105	95	96	76
Antero-posterior diameter of postzygapophyses	30	22	40	r. 31, l. 20	23	r. 29, l. 25	18
Transverse diameter of postzygapophyses	24	22	23	r. 22, l. 28	20	r. 30, l. 26	r. 13, l. 17
Distance across postzygapophyses	69	62	77	62	57	73	45
Transverse diameter of anterior face for head of rib	*30*	20	20	20	20	25	13
Horizontal diameter of anterior face for head of rib	26	25	28	30	20	28	18
Vertical diameter of posterior face for head of rib	29	25	32	..	..	25	..
Transverse diameter of posterior face for head of rib	23	17	25	..	..	19	..
Antero-posterior diameter of face for tubercle of rib	23	26	38	..	30	37	25
Transverse diameter of face for tubercle of rib	26	20	30	..	20	25	15
Transverse diameter of pedicel	40	30	40	35	35	31	26
Antero-posterior diameter of pedicel at narrowest part	33	20	22	20	20	20	17
Distance between faces for head of ribs	10	10	15	15	10	13	7
Height of spine from neural canal to extremity	235	160	217	214	153	176	128
Antero-postero diameter of spine above neural canal	53	30	55	40	30	35	30
Antero-posterior diameter of spine at top	*40*	20	35	48	20	31	20

Third Dorsal Vertebra.

Three specimens of the third dorsal vertebra of *Moropus* were found in the Agate Spring Quarry, Nos. 1604, 1703*B* (see Fig. 48), and 1712. Of these specimens No. 1712 is in almost perfect condition (see Fig. 43, 3), the top of the spine and the front of the centrum having sustained some slight injury, but not enough to make it impossible to almost exactly approximate its length. In specimen No. 1604 we have the posterior and upper portions of the centrum, the pedicel, the prezygapophyses, and the postzygapophyses, and the lower half of the spine. The front of the centrum, the extremities of the transverse processes, and the upper half of the spine have been restored.

The spine of the third dorsal vertebra is relatively longer than that of the second dorsal. It is, like the second, triangular in horizontal cross-section, but broader behind than the second and shorter in its antero-posterior diameter. The tubercular end of the transverse process is smaller than in the second vertebra and the articulating face for the tubercle looks downward, outward, and slightly forward. The prezygapophyses look upward and outward; the postzygapophyses look downward and inward. The articulating surfaces of the centrum resemble those of the second dorsal, and the body of the centrum is clasped from before and behind by the median projections of the epiphyses on the under side, which form a low keel.

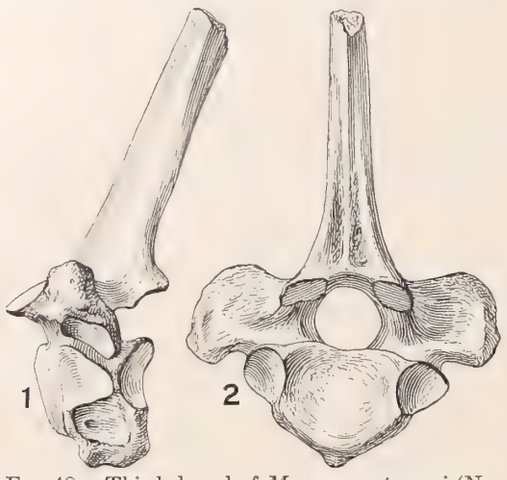


FIG. 48. Third dorsal of *Moropus petersoni* (No. 1703*B*). 1, lateral view; 2, posterior view. $\times\frac{1}{3}$.

MEASUREMENTS OF THIRD DORSAL VERTEBRA.[25]

	1604, mm.	1703*B*, mm.	1712, mm.
Greatest height from base of centrum to top of spine	*327*	*250*	310
Greatest transverse diameter, measured across transverse processes	*166*	130	145
Greatest antero-posterior diameter, measured from front of prezygapophyses to back of postzygapophyses	78	63	70
Length of centrum along floor of neural canal	*52*	43	*50*
Length of centrum along inferior surface	45	25	37
Vertical diameter of anterior face of centrum	*55*	45	48
Transverse diameter of anterior face of centrum	*41*	41	42
Vertical diameter of posterior face of centrum	60	45	55
Transverse diameter of posterior face of centrum including faces for head of ribs	*101*	86	98
Vertical diameter of neural canal	26	28	33
Transverse diameter of neural canal	28	28	33
Antero-posterior diameter of prezygapophyses	r. 20, l. 27	28	36
Transverse diameter of prezygapophyses	r. 19, l. 23	37	25
Distance across prezygapophyses	*60*	70	75
Antero-posterior diameter of postzygapophyses	*22*	20	r. 25, l. 20
Transverse diameter of postzygapophyses	*21*	15	20
Distance across postzygapophyses	*58*	55	62
Transverse diameter of anterior face for head of ribs	26	23	25
Horizontal diameter of anterior face for head of ribs	35	28	34
Transverse diameter of posterior face for head of ribs	25	20	24

[25] Numbers italicized indicate that at the point of measurement the specimen has been injured or restored.

Vertical diameter of posterior face for head of ribs	*30*	25	32
Antero-posterior diameter of face for tubercle of rib	*28*	26	26
Transverse diameter of face for tubercle of rib	*22*	17	18
Transverse diameter of pedicel	40	32	30
Antero-posterior diameter of pedicel	35	28	32
Distance between faces for head of ribs	5	2	2
Height of spine from neural canal to extremity	*240*	*180*	226
Antero-posterior diameter of spine above neural canal	43	30	45
Antero-posterior diameter of spine at top	*43*	*22*	35

Fourth Dorsal Vertebra.

Four specimens of the fourth dorsal vertebra were recovered in the Agate Spring Quarries, Nos. 1604, 1703*B*, 1712, and 1715 (Carn. Mus. Cat. Vert. Foss.). No. 1604 lacks the upper end of the spine, and has sustained some injury at the extremity of the transverse processes. Nos. 1703*B* (see Fig. 49) and 1712 (see Fig. 45, 4) are practically perfect. No. 1715 has lost the extremity of the left transverse process, and is a little water-worn; otherwise it is in good conditoon.

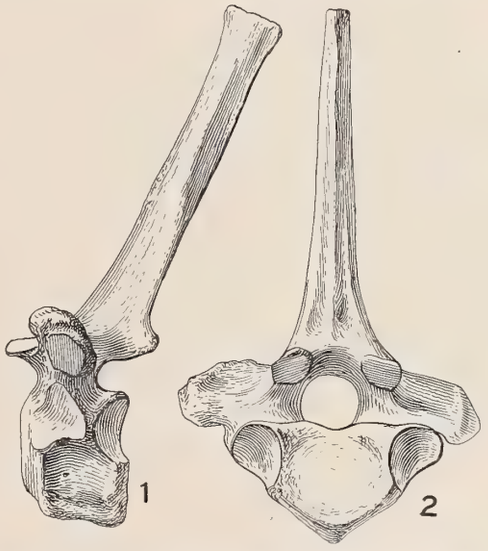


FIG. 49. Fourth dorsal of *Moropus petersoni* (No. 1703*B*). ×¾. 1, lateral view; 2, posterior view.

The spine of the fourth dorsal is slightly longer than the third (see Fig. 43). In horizontal section at its origin it is equilaterally triangular. The transverse processes are smaller than in the preceding vertebra, and are the first to show the tendency to develop a metapophysis, which becomes gradually more marked as we go backward along the vertebræ. The superior margin of the centrum above the posterior articular faces for the heads of the ribs projects a little upward, assisting thus in forming a portion of the wall of the lateral exits for the nerves of the spine. The prezygapophyses look forward and outward, and are subtriangular. The postzygapophyses look obliquely downward and a little inward and are anteroposteriorly oblong. Both the pre- and postzygapophyses are relatively smaller than in the preceding vertebra. The articulating surface for the tubercle is situated at the outer extremity of the transverse process and forms the surface of a very short oval or circular lateral projection which is separated from the body of

the process by a shallow constriction deeper on the lower anterior side than above. The articular surface looks outward, downward, and forward. The articulating surfaces of the centrum both before and behind are nearly vertical in position.

MEASUREMENTS OF FOURTH DORSAL VERTEBRA.[26]

	1604, mm.	1703*B*, mm.	1712, mm.	1715, mm.
Greatest height from base of centrum to top of spine	*308*	222	295	233
Greatest transverse diameter measured across transverse processes	*165*	130	129	*120*
Greatest antero-posterior diameter measured from front of prezygapophyses to back of postzygapophyses	63	66	65	52
Length of centrum along floor of neural canal	45	38	41	37
Length of centrum along inferior surface	50	38	38	27
Vertical diameter of anterior face of centrum	50	40	50	40
Transverse diameter of anterior face of centrum	57	40	47	38
Vertical diameter of posterior face of centrum	58	43	55	42
Transverse diameter of posterior face of centrum including faces for head of ribs	108	90	102	*77*
Vertical diameter of neural canal	28	27	26	25
Transverse diameter of neural canal	30	25	26	22
Antero-posterior diameter of prezygapophyses	20	22	r. 23, l. 27	r. 20, l. 16
Transverse diameter of prezygapophyses	20	19	22	15
Distance across prezygapophyses	60	60	62	50
Antero-posterior diameter of postzygapophyses	26	19	18	22
Transverse diameter of postzygapophyses	21	r. 18, l. 15	r. 16, l. 14	15
Distance across postzygapophyses	66	55	50	42
Vertical diameter of anterior face for head of rib	27	25	32	25
Horizontal diameter of anterior face for head of rib	38	28	32	25
Vertical diameter of posterior face for head of rib	35	28	32	27
Horizontal diameter of posterior face for head of rib	29	23	27	17
Antero-posterior diameter of surface for tubercle of rib	30	23	17	15
Vertical diameter of surface for tubercle of rib	20	20	17	15
Transverse diameter of pedicel	40	32	30	30
Antero-posterior diameter of pedicel	30	25	25	24
Distance between faces for head of rib	3	2	2	1
Height of spine from neural canal to extremity	240	163	230	167
Antero-posterior diameter of spine above neural canal	45	30	35	32
Antero-posterior diameter of spine at top	34	22	30	22

Fifth Dorsal Vertebra.

Three specimens of the fifth dorsal of *Moropus* were recovered in the Agate Spring Quarries, No. 1604, No. 1712, and No. 1713. The vertebra of No. 1604 is

[26] Numbers italicized indicate that they are only approximate, the specimen having been broken or restored.

rather defective. The anterior face of the centrum was lost and has been restored. The extremities of both transverse processes were more or less mutilated and the upper end of the dorsal spine was gone. No. 1712 (see Fig. 43) is a practically perfect specimen, somewhat smaller than No. 1604. With its well-preserved surfaces before him, Mr. Peterson has been able to repair specimen No. 1604 in an excellent manner. No. 1713 has lost the epiphyses of the centrum and is badly crushed and distorted about the neural arch.

The spine of the fifth dorsal is somewhat shorter than that of the preceding vertebra, and in horizontal cross-section at its origin is almost equilaterally triangular. It preserves almost the same antero-posterior diameter from the base to the extremity, though at the tip it is, as all of the dorsal vertebræ, somewhat swollen to form ligamentary attachments. The transverse processes have a rather well defined mammillary projection the transverse diameter of which is fully twice that of the antero-posterior dimension. The articulating face for the tubercle of the rib is separated from the mammillary by a shallow constriction, deeper below than above, and looks outward and slightly forward. The prezygapophyses are relatively small, look upward and slightly forward. The postzygapophyses are quite small and look downward and somewhat inward. The upper margin of the centrum on its outer fourth rolls upward more than in the fourth dorsal to assist in forming the back wall of the exit for the spinal nerve. The anterior and posterior articulating faces of the centrum are vertical in position, the former slightly convex, the latter slightly concave, as is the case in the preceding and succeeding vertebræ. In specimen No. 1604 there is in the posterior face of the transverse process a transversely longitudinal depression already indicating the commencement of the formation of the shaft of the metapophysis. This does not appear in specimen No. 1712. It is reproduced, however, in succeeding vertebræ, as will be shown.

Measurements of Fifth Dorsal Vertebra.[27]

	1604, mm.	1712, mm.	1713, mm.
Greatest height from base of centrum to top of spine	285	283	*255*
Greatest transverse diameter measured across transverse processes	154	130	*120*
Greatest antero-posterior diameter measured from front of prezygapophyses to back of postzygapophyses	72	58	*63*
Length of centrum along floor of neural canal	47	42	38
Length of centrum along inferior surface	40	38	*30*
Vertical diameter of anterior face of centrum	50	44	43
Transverse diameter of anterior face of centrum	46	44	45

[27] All numbers in italics denote approximate measurements, the specimens being broken or restored.

Vertical diameter of posterior face of centrum	53	47	*43*
Vertical diameter of posterior face of centrum including faces for heads of ribs	106	98	*93*
Vertical diameter of neural canal	28	27	*24*
Transverse diameter of neural canal	23	23	*24*
Antero-posterior diameter of prezygapophyses	20	16	15
Transverse diameter of prezygapophyses	19	r. 16, l. 19	*23*
Distance across prezygapophyses	57	57	60
Antero-posterior diameter of postzygapophyses	27	r. 15, l. 12	15
Transverse diameter of postzygapophyses	16	14	r. 30, l. 25
Distance across postzygapophyses	58	44	47
Transverse diameter of anterior face for head of rib	30	30	28
Horizontal diameter of anterior face for head of rib	33	30	28
Vertical diameter of posterior face for head of rib	35	36	*30*
Horizontal diameter of posterior face for head of rib	30	28	28
Horizontal diameter of surface for tubercle of rib	*22*	20	*20*
Transverse diameter of surface for tubercle of rib	*16*	19	*17*
Transverse diameter of pedicel	39	34	30
Antero-posterior diameter of pedicel	30	26	22
Distance between faces for head of rib	5	r. 5, l. 2	r. 1, l. 10
Height of spine from neural canal to extremity	230	217	202
Antero-posterior diameter of spine above neural canal	40	32	33
Antero-posterior diameter of spine at top	*40*	34	28

The Sixth Dorsal.

Four specimens of the sixth dorsal of *Moropus* were recovered, Nos. 1604, 1713, 1714, and 1715. Of these No. 1604 is more nearly perfect than any of the others, but has sustained some injuries. No. 1715, the smallest of the four, is likewise nearly perfect except for some crushing in the region of the postzygapophyses. Nos. 1713 and 1714 have lost the epiphysial faces of the centra both before and behind, and 1713 is malformed, having apparently during the life of the animal received injuries leading to a shortening of the left pedicel and the consequent twisting of the dorsal spine to the left. The opening of the neural canal in this specimen is likewise from the same cause abnormal, its longest (vertical) axis being thrown toward the left side.

The spine of the sixth dorsal is shorter than that of its predecessor, though elongated. It is not greatly diminished in its antero-posterior diameter at its extremity. The transverse process behind shows a deep longitudinal depression marking the posterior boundary of the nascent metapophysis, which lies on the upper side of the process as a ridge, terminating broadly at the outer tubercular extremity of the process in a mammillary protuberance which in this vertebra is separated from the lower part of the end of the process bearing the face for the

tubercule of the rib by a very faint depression. This depression grows deeper as we follow it in the succeeding vertebræ. The outer fourths of the posterior articulating surface of the centrum (the upper margins of the posterior articulating faces for the heads of the ribs) are still more strongly bent upward than in the fifth dorsal, and are widened antero-posteriorly, so as to form a deep groove for the exit of the nerve from the spine, composing about three-fourths of the circumference of the intervertebral foramen in specimens 1604 and 1713. In specimens 1714 and 1715 this feature is not so strongly marked. The anterior and posterior faces of the centra are practically vertical. The prezygapophyses look upward and very slightly forward; the postzygapophyses look downward, slightly backward, and very slightly inward. The faces for the tubercle of the rib are suboval or nearly circular, and look outward and slightly downward. As has been noted in the case of the preceding vertebræ, there is a very shallow keel-like projection on the under side, formed by an anterior and posterior projection of the cartilaginous epiphysis, which are shown in specimen No. 1714 to have been received into shallow grooves or notches on the lower side of the centrum in the early life of the animal. These features are largely obliterated in the older and larger specimens, where a complete ossification has taken place. The distance between the articulating faces for the head of the ribs begins to increase in the sixth dorsal. In the preceding vertebræ they are very close to each other. The anterior face in this vertebra at its upper margin is thrown forward, being borne in its upper half upon a short pedicel, the superior margin of which assists in forming the lower margin of the intervertebral foramen.

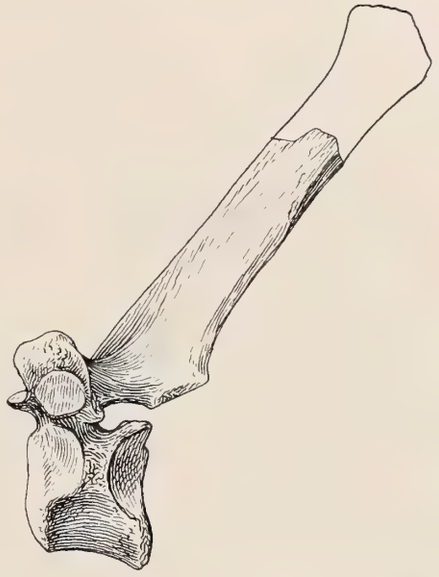


FIG. 50. Sixth dorsal of *M. elatus* (No. 1604). $\times\frac{1}{3}$.

MEASUREMENTS OF SIXTH DORSAL VERTEBRA.[28]

	1604, mm.	1713, mm.	1714, mm.	1715, mm.
Greatest height from base of centrum to top of spine	260	242	197	196
Greatest transverse diameter measured across transverse processes	*140*	121	113	103
Greatest antero-posterior diameter measured from front of prezygapophyses to back of postzygapophyses	77	68	68	56

[28] Numbers in italics denote approximate dimensions, the specimen being broken or restored.

Length of centrum along floor of neural canal	50	*32*	*32*	33
Length of centrum along inferior surface	45	*31*	*25*	33
Vertical diameter of anterior face of centrum	47	*42*	*37*	38
Transverse diameter of anterior face of centrum	51	*42*	*44*	38
Vertical diameter of posterior face of centrum	*52*	*42*	*38*	38
Transverse diameter of posterior face of centrum including faces for head of ribs	102	*90*	*78*	*72*
Vertical diameter of neural canal	22	24	23	22
Transverse diameter of neural canal	27	24	22	22
Antero-posterior diameter of prezygapophyses	18	16	15	r. 14, l. 12
Transverse diameter of prezygapophyses	15	18	12	r. 17, l. 13
Distance across prezygapophyses	52	55	44	44
Antero-posterior diameter of postzygapophyses	27	21	13	*20*
Transverse diameter of postzygapophyses	16	13	13	*10*
Distance across postzygapophyses	59	48	37	*40*
Horizontal diameter of anterior face for head of rib	31	22	17	18
Transverse diameter of anterior face for head of rib	35	*23*	24	28
Vertical diameter of posterior face for head of rib	31	30	*22*	27
Horizontal diameter of posterior face for head of rib	27	23	*18*	18
Antero-posterior diameter of face for tubercle of rib	22	24	19	15
Transverse diameter of face for tubercle of rib	22	23	19	16
Transverse diameter of pedicel	39	32	26	26
Antero-posterior diameter of pedicel	*26*	28	22	21
Distances between faces for head of rib	r. 10, l. 6	r. 12, l. 8	8	6
Height of spine from neural canal to extremity	*200*	170	150	150
Antero-posterior diameter of spine above neural canal	40	33	30	28
Antero-posterior diameter of spine at top	32	29	25	21

The Seventh Dorsal.

We have four specimens of the seventh dorsal, Nos. 1604, 1703*C*, 1713, and 1714. The seventh dorsal of No. 1604 is nearly perfect except that it has sustained some injury from crushing near the origin of the spine. No. 1703*C* is perfect in the region of the centrum, but the upper end of the spine has sustained some injuries, though not enough to prevent its length and general measurements to be ascertained. No. 1714 has lost the posterior epiphysis of the centrum, the end of the right transverse process, and has also sustained some injury to the spine a little above the middle, which has been repaired at this point. No. 1713 has lost the posterior epiphysis of the centrum, but is otherwise perfect.

The length of the spine in this vertebra is much less than in the preceding vertebra. It rakes backward. The transverse process tends to increase in its vertical dimensions and both before and behind reveals deep longitudinal transverse depressions, forming the anterior and posterior boundaries of the nascent

metapophysis, which is still fused with the rest of the process and terminates exteriorly in a rugose mammillary extremity, between the lower margin of which and the rim of the tubercular facet is a shallow constriction. The distance between the articular faces for the heads of the ribs is greatly increased in this vertebra. The articulating faces of the centrum are perpendicular. The prezygapophyses look almost directly upward, very slightly outward and forward. The postzygapophyses look downward, very slightly backward and inward. The articular faces for the tubercle of the rib look outward and a little forward. The upper half of the anterior face for the head of the rib is supported as in the sixth dorsal, but lies farther back and more on the under side of the radix than in the preceding vertebra. The upper lip-like margin of the posterior face for the head of the rib assists, as in the sixth dorsal, in forming a considerable portion of the posterior wall of the intervertebral foramen.

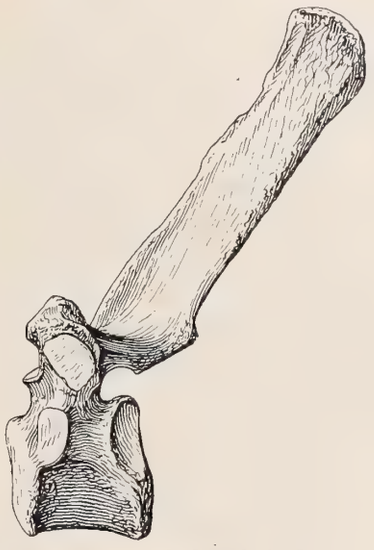


FIG. 51. Seventh dorsal of *M. elatus* (No. 1604). $\times\frac{1}{3}$.

MEASUREMENTS OF SEVENTH DORSAL VERTEBRA.[29]

	1604, mm.	1703*C*, mm.	1713, mm.	1714, mm.
Greatest height from base of centrum to top of spine	*245*	194	238	195
Greatest transverse diameter measured across transverse processes	134	98	128	118
Greatest antero-posterior diameter measured from front of prezygapophyses to back of postzygapophyses	*74*	60	70	60
Length of centrum along floor of neural canal	50	41	*39*	*40*
Length of centrum along inferior surface	48	39	*40*	*36*
Vertical diameter of anterior face of centrum	47	38	46	38
Transverse diameter of anterior face of centrum	50	42	54	45
Vertical diameter of posterior face of centrum	50	39	*46*	*37*
Transverse diameter of posterior face of centrum including faces for head of ribs	100	65	*90*	75
Vertical diameter of neural canal	26	18	24	23
Transverse diameter of neural canal	26	20	24	23
Antero-posterior diameter of prezygapophyses	20	r. 20, l. 15	15	15
Transverse diameter of prezygapophyses	r. 16, l. 20	r. 16, l. 13	17	17
Distance across prezygapophyses	60	38	55	48
Antero-posterior diameter of postzygapophyses	26	23	24	r. 15, l. 17

[29] Numbers in italics represent approximate measurements.

Transverse diameter of postzygapophyses	16	14	15	r. 11, l. 12
Distance across postzygapophyses	60	39	48	37
Greatest horizontal diameter of anterior face for head of rib	26	12	20	14
Transverse diameter of anterior face for head of rib	32	22	27	22
Greatest vertical diameter of posterior face for head of rib	30	22	*28*	*20*
Greatest horizontal diameter of posterior face for head of rib	30	16	*23*	*20*
Greatest antero-posterior diameter of face for tubercle of rib	*20*	20	22	20
Greatest vertical diameter of face for tubercle of rib	*22*	22	22	17
Transverse diameter of pedicel	31	20	26	25
Antero-posterior diameter of pedicel	26	24	23	22
Distance between faces for head of rib	18	18	r. 8, l. 15	3
Height of spine from neural canal to extremity	180	145	173	145
Antero-posterior diameter of spine above neural canal	40	33	35	30
Antero-posterior diameter of spine below tubercle at top	30	20	25	20

Eighth Dorsal Vertebra.

Unfortunately no specimen of the eighth dorsal was found in any of the material collected except the centrum of a large and fully adult specimen which has received the Catalogue Number 1731. This was associated with the centra of the 9th and 10th dorsals of the same individual. The specimens came from Quarry No. 2 and were found by Mr. Utterback as surface fragments lying close together. This centrum has been employed in reproducing the eighth dorsal in the mounted specimen. The spine, the postzygapophyses, and the transverse processes are modelled after the analogies of the seventh and ninth vertebræ, of which we have well-preserved specimens, so that a very close approximation to the true form of the bone has been effected.

Fig. 52. Eighth dorsal of *Moropus* (No 1731). ×⅓.

Measurements of Eighth Dorsal Vertebra.[30]

	1604, mm.	1731, mm.
Greatest height from base of centrum to top of spine	*240*	..
Greatest transverse diameter measured across transverse process	*140*	..
Greatest antero-posterior diameter measured from front of prezygapophyses to back of postzygapophyses	*83*	..
Length of centrum along floor of neural canal	*53*	50
Length of centrum along inferior surface	*48*	42

[30] Figures in italics are approximate only, the specimen having been restored.

Vertical diameter of anterior face of centrum	*48*	*45*
Transverse diameter of anterior face of centrum	*55*	55
Vertical diameter of posterior face of centrum	*53*	50
Transverse diameter of posterior face of centrum	*60*	60
Vertical diameter of neural canal	*25*	*25*
Transverse diameter of neural canal	*30*	30
Antero-posterior diameter of prezygapophyses	*20*	22
Transverse diameter of prezygapophyses	*20*	18
Distance across prezygapophyses	*54*	54
Antero-posterior diameter of postzygapophyses	*25*	..
Transverse diameter of postzygapophyses	*18*	..
Distance across postzygapophyses	*58*	..
Vertical diameter of anterior face for head of ribs	*27*	25
Horizontal diameter of anterior face for head of ribs	*17*	17
Vertical diameter of posterior face for head of ribs	*24*	23
Horizontal diameter of posterior face for head of ribs	*24*	23
Antero-posterior diameter for tubercle of ribs	*25*	..
Vertical diameter for tubercle of ribs	*25*	..
Transverse diameter of pedicel	*32*	*29*
Antero-posterior diameter of pedicel	*34*	33
Distance between faces for heads of ribs	*24*	24
Height of spine from neural canal to extremity	*175*	..
Antero-posterior diameter of spine above neural canal	*40*	..
Antero-posterior diameter of spine at top below tubercle	*32*	..

Ninth Dorsal Vertebra.

Three specimens representing the ninth dorsal of *Moropus* were found: No. 1604, in an excellent state of preservation; No. 1714, likewise in a good state of preservation, except that it has lost the posterior epiphysis of the centrum; and the centrum of specimen No. 1731, preserving together with the corpus the anterior prezygapophyses and portions of the laminæ forming the neural arch. The specimen 1714 is that of a quite small and immature individual.

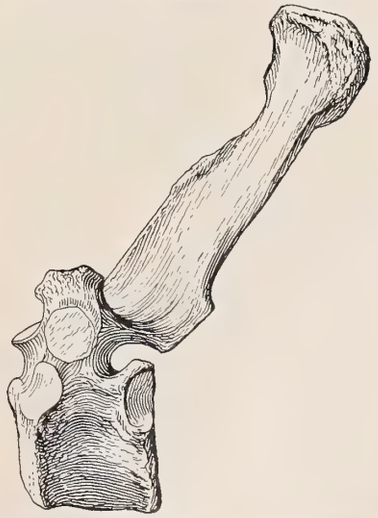


Fig. 53. Ninth dorsal of *M. elatus* (No. 1604). ×⅓.

The spine of the ninth dorsal is very nearly the same height as that of the eighth and the tenth, and is somewhat strongly excavated anteriorly at the upper end of its extremity and has at the end a strongly developed tubercle for ligamentary attachments. The prezygapophyses in Number 1604 look forward more decidedly than in specimens Nos. 1714 and 1731. The postzygapophyses look

backward, downward, and very slightly inward. The transverse processes display an advance over the preceding vertebræ in the development of the metapophysis. The terminal portion of the transverse process is marked about its middle by a moderately deep sulcus separating the articulating face for the rib from the superior mammillary process which is directed strongly upward, terminating the outer extremity of the superior portion of the lamina which begins in this vertebra more distinctly to separate itself as an upward extension from the radix. The distance between the articulating faces for the heads of the ribs is distinctly greater than in the preceding vertebra. The anterior articulating surface in all the specimens appears to be supported upon a very short pedicel the superior margin of which forms a portion of the inferior boundary of the intervertebral foramen. The upper lip of the posterior articulating face for the head of the rib is, as in the preceding vertebra, carried upward and thickened antero-posteriorly in such a way as to largely form the posterior margin of the intervertebral foramen, three-fourths of the boundaries of which are included within the ninth vertebra.

Measurements of Ninth Dorsal Vertebra.[31]

	1604, mm.	1714, mm.	1731, mm.
Greatest height from base of centrum to top of spine	235	153	..
Greatest transverse diameter measured across transverse processes	130	94	..
Greatest antero-posterior diameter measured from front of prezygapophyses to back of postzygapophyses	90	75	..
Length of centrum along floor of neural canal	54	42	52
Length of centrum along inferior surface	52	*35*	49
Vertical diameter of anterior face of centrum	52	40	47
Transverse diameter of anterior face of centrum	59	47	56
Vertical diameter of posterior face of centrum	54	*40*	50
Transverse diameter of posterior face of centrum including faces for heads of ribs	95	*71*	*78*
Vertical diameter of neural canal	25	21	22
Transverse diameter of neural canal	25	22	25
Antero-posterior diameter of prezygapophyses	21	21	r. 20, l. 26
Transverse diameter of prezygapophyses	17	15	r. 15, l. 18
Distance across prezygapophyses	60	45	48
Antero-posterior diameter of postzygapophyses	r. 36, l. 31	r. 23, l. 18	..
Transverse diameter of postzygapophyses	17	r. 15, l. 8[32]	..
Distance across postzygapophyses	56	43	..
Vertical diameter of anterior face for head of ribs	27	14	18
Horizontal diameter of anterior face for head of rib	15	10	17
Vertical diameter of posterior face for head of rib	25	*22*	22

[31] Numbers italicized denote approximate measurements.

[32] The left postzygapophysis is dwarfed.

Horizontal diameter of posterior face for head of rib	20	*17*	20
Antero-posterior diameter of face for tubercle of rib	25	17	..
Transverse diameter of face for tubercle of rib	22	16	..
Transverse diameter of pedicel	33	23	27
Antero-posterior diameter of pedicel	35	28	33
Distance between faces for head of ribs	26	25	*24*
Height of spine from neural canal to extremity	168	97	..
Antero-posterior diameter of spine above neural canal	40	32	..
Antero-posterior diameter of spine at top below tubercle	30	24	..

The Tenth Dorsal Vertebra.

Three specimens representing the tenth dorsal were recovered, No. 1604, No. 1713, and the centrum of No. 1731. No. 1604 preserves a considerable portion of the centrum, though greatly injured on the anterior face, which has been restored. The entire neural arch, the right transverse process, and the spine are well preserved in this specimen. The extremity of the left transverse process was broken and has been restored to conform to the process on the right, which is well preserved. In specimen No. 1713 the bone is quite complete, lacking only the posterior epiphysis of the centrum and the articulating face for the tubercle of the rib on the left side. Specimen No. 1713 is evidently that of an immature animal somewhat smaller than specimen No. 1604. There is considerable difference in the form of the upper end of the spine. The tubercular thickening at the extremity of the spine is not nearly so massive, though quite as broad, as in specimen No. 1604. The centrum of specimen No. 1731 is well preserved, though the articulating surfaces for the heads of the rib have sustained considerable damage. The prezygapophyses are preserved in position in this specimen and enough of the neural arch to indicate approximately the correct measurements; the transverse processes and the spine are lost.

FIG. 54. Tenth dorsal of *M. elatus* (No. 1604). $\times\frac{1}{3}$.

The length of the spine in the tenth dorsal is very nearly the same as in the preceding and succeeding dorsals. At the upper extremity it is rugose and greatly thickened for ligamentary attachments. In specimen No. 1604 the upper extremity of the spine is deeply excavated like the ninth dorsal in the same specimen and the upper extremity is somewhat falcate in outline. This backward curving of the superior half of the spine is not seen in specimen No. 1713. The prezygapophyses in No. 1604 look upward, strongly forward, and slightly outward. They

look much more strongly forward than in specimen No. 1713 and specimen No. 1731. This forward aspect of the prezygapophyses is characteristic not only of this vertebra, but of all the succeeding vertebræ of the dorsal series in specimen No. 1604, and though it might be interpreted as a possible result of age in this large specimen, the writer is inclined to regard it as indicating with other things a specific difference. It is at all events a strongly marked and constant feature. The postzygapophyses in specimen No. 1604, look backward and downward, almost imperceptibly inward; but more strongly inward in specimen No. 1713. The transverse process in the tenth dorsal indicates modifications in form which are noticeable. The articulating surface for the tuberculum of the rib is separated from the mass of the transverse process by a narrow sulcus which is deeper below than above. The mammillary process is elevated and extended forward as a sharp anterior projection overhanging the prezygapophyses. The articulating faces for the heads of the ribs are widely separated and the superior margin of the posterior articulating surface for the head of the rib is strongly bent upward as a lip-like projection, forming a large portion of the posterior margin of the intervertebral foramen. In specimen No. 1713 a small posterior projection from the back of the lamina above is sent forth to meet this lip-like projection, so that a very large portion of the intervertebral foramen is enclosed within the bone of the vertebra.

Measurements of Tenth Dorsal Vertebra.[33]

	1604, mm.	1713, mm.	1731, mm.
Greatest height from base of centrum to top of spine	223	208	..
Greatest transverse diameter measured across transverse processes	*123*	109	..
Greatest antero-posterior diameter measured from front of prezygapophyses to back of postzygapophyses	84	77	..
Length of centrum along floor of neural canal	52	*46*	*56*
Length of centrum along inferior surface	48	*40*	52
Vertical diameter of anterior face of centrum	48	48	52
Transverse diameter of anterior face of centrum	58	52	65
Vertical diameter of posterior face of centrum	60	*48*	56
Transverse diameter of posterior face of centrum including faces for heads of ribs	93	83	92
Vertical diameter of neural canal	25	22	23
Transverse diameter of neural canal	25	22	23
Antero-posterior diameter of prezygapophyses	26	28	27
Transverse diameter of prezygapophyses	16	*15*	17
Distance across prezygapophyses	54	54	60
Antero-posterior diameter of postzygapophyses	32	27	..
Transverse diameter of postzygapophyses	15	17	..
Distance across postzygapophyses	50	50	..

[33] Figures in italics denote approximate measurements,

Vertical diameter of anterior face for heads of ribs	24	22	17
Horizontal diameter of anterior face for head of rib	*13*	13	16
Vertical diameter of posterior face for head of rib	30	*27*	25
Horizontal diameter of posterior face for head of rib	22	20	22
Antero-posterior diameter of face for tubercle of rib	24	22	..
Transverse diameter of face for tubercle of rib	22	24	..
Transverse diameter of pedicel	25	26	32
Antero-posterior diameter of pedicel	37	34	35
Distance between faces for head of rib	28	22	30
Height of spine from neural canal to extremity	158	142	..
Antero-posterior diameter of spine above neural canal	45	40	..
Antero-posterior diameter of spine at top	30	28	..

The Eleventh Dorsal Vertebra.

But two specimens representing this element in the dorsal series were found. The first belongs to the series of dorsals designated in the Carnegie Museum Catalogue of Vertebrate Fossils as 1703*C* (see Fig. 56). It is very well preserved

FIG. 55. Restoration in outline of eleventh dorsal of *M. elatus* (No. 1604). $\times\frac{1}{3}$.

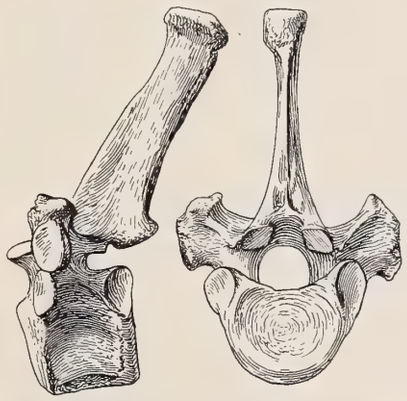


FIG. 56. Eleventh dorsal of *M. petersoni* (C. M. Cat. Vert. Foss. No. 1703*C*). $\times\frac{1}{3}$.

and has sustained practically no injuries whatever. The other is a centrum belonging to the series numbered 1708. Using these specimens as models, Mr. Peterson has made for the mounted specimen No. 1604 an enlargement, modified so far as the end of the spine and the articulating faces are concerned in order to adjust itself to the preceding and succeeding vertebræ in No. 1604 (see Fig. 55). In specimen No. 1708 the anterior margins of the prezygapophyses agree more nearly with the same surfaces in No. 1604 and look more directly forward than they do in the smaller specimen, showing that No. 1708 is a specimen of *Moropus elatus* Marsh.

The spine of dorsal eleven is of the same relative height as the dorsals which precede and succeed it. At the upper extremity of the spine it is enlarged for ligamentary attachments and is concave anteriorly and convex posteriorly in such a way as to give the upper extremity of the spine a slightly falcate outline. The prezygapophyses in No. 1703*C* look upward and slightly outward; in No. 1708 they look upward and strongly forward. The postzygapophyses look backward and downward and very slightly inward. The transverse processes are bi-tuberculate at their extremity, the upper or mammillary portion being considerably elevated, the lower and outer portion, bearing the tuberculum of the rib, looking outward and slightly forward. The faces for the heads of the ribs are well separated from each other.

MEASUREMENTS OF ELEVENTH DORSAL VERTEBRA.[34]

	1604, mm.	1703*C*, mm.	1708, mm.
Greatest height from base of centrum to top of spine	*222*	166	..
Greatest transverse diameter measured across transverse processes	*130*	96	..
Greatest antero-posterior diameter measured from front of prezygapophyses to back of postzygapophyses	*84*	*78*	..
Length of centrum along floor of neural canal	*56*	44	56
Length of centrum along inferior surface	45	37	45
Vertical diameter of anterior face of centrum	*60*	35	55
Transverse diameter of anterior face of centrum	*63*	43	56
Vertical diameter of posterior face of centrum	*60*	38	54
Transverse diameter of posterior face of centrum including faces for heads of ribs	*92*	65	90
Vertical diameter of neural canal	*25*	21	21
Transverse diameter of neural canal	*25*	21	21
Antero-posterior diameter of prezygapophyses	*25*	18	30
Transverse diameter of prezygapophyses	*13*	12	18
Distance across prezygapophyses	*48*	41	54
Antero-posterior diameter of postzygapophyses	*30*	19	27
Transverse diameter of postzygapophyses	*16*	13	20
Distance across postzygapophyses	*57*	39	56
Vertical diameter of anterior face for head of ribs	25	19	*20*
Horizontal diameter of anterior face for head of ribs	*20*	12	*16*
Vertical diameter of posterior face for head of ribs	*25*	23	23
Horizontal diameter of posterior face for head of ribs	*20*	17	20
Antero-posterior diameter of face for tubercle of ribs	*17*	18	..
Vertical diameter of face for tubercle of ribs	*23*	20	..
Transverse diameter of pedicel	*31*	21	30
Antero-posterior diameter of pedicel	*34*	25	34
Distance between faces for heads of ribs	*28*	20	30
Height of spine from neural canal to extremity	*157*	118	..
Antero-posterior diameter of spine above neural canal	*40*	29	..
Antero-posterior diameter of spine at top below tubercular enlargement	*42*	21	..

[34] Figures in italics denote approximate measurements.

Twelfth Dorsal Vertebra.

Five specimens representing this member of the vertebral series were recovered: No. 1604, No. 1703*C*, No. 1708, No. 1713, and No. 1715. Specimen No. 1604 consists of the centrum, the neural arch, the lower half of the spine, the left transverse process, which has been very slightly injured, and the base of the right transverse process, the extremity being lost (see Fig. 57). No. 1703*C* consists of a well-preserved centrum, the neural arch, and the lower two-thirds of the spine. The right transverse process has been well preserved; the left transverse process has been broken off near its end. No. 1708 is a fragment of the centrum. No. 1713 is complete except for the loss of the posterior epiphysis of the centrum. Specimen No. 1715 is almost perfect with exception of the face for the tubercle of the rib on the right side, which has sustained injury; it is also slightly waterworn on the articulating faces of the centrum; no injury has been sustained by the spine. With the help of the latter specimen Mr. Peterson was able to repair the specimen belonging to No. 1604 in such a way as to leave no doubt as to the correctness of the restoration.

FIG. 57. Twelfth dorsal of *M. elatus* (No. 1604). ×⅓.

The spine of the twelfth dorsal vertebra has about the same height as that of the vertebra preceding and succeeding it. Its upper extremity, like that of its predecessor, is somewhat bent, giving its upper end a hooked appearance. At the tip it is broadened transversely to form ligamentary attachments. In specimen No. 1604 the prezygapophyses look upward and strongly forward; the postzygapophyses look backward and somewhat downward, very slightly inward. The transverse process at its extremity is broadened vertically. The mammillary process having a sharpened projection which overhangs the prezygapophyses, the surface for the tubercle of the rib looks outward and slightly forward. The articulating faces for the heads of the ribs are widely separated and are relatively smaller than in the case of the preceding vertebra.

MEASUREMENTS OF TWELFTH DORSAL VERTEBRA.[35]

	1604, mm.	1703*C*, mm.	1708, mm.	1713, mm.	1715, mm.
Greatest height from base of centrum to top of spine	*214*	..	..	217	154
Greatest transverse diameter measured across transverse processes	117	*90*	..	118	*95*

[35] Numbers in italics represent approximate measurements, the specimens being broken or restored.

Greatest antero-posterior diameter measured from front of prezygapophyses to back of postzygapophyses	86	62	..	77	61
Length of centrum along floor of neural canal	56	40	56	42	40
Length of centrum along inferior surface	45	37	45	40	37
Vertical diameter of anterior face of centrum	50	33	50	50	38
Transverse diameter of anterior face of centrum	62	45	..	54	48
Vertical diameter of posterior face of centrum	60	40	60	*50*	48
Transverse diameter of posterior face of centrum including faces for heads of ribs	95	70	97	*90*	70
Vertical diameter of neural canal	25	23	*25*	21	22
Transverse diameter of neural canal	27	23	..	22	22
Antero-posterior diameter of prezygapophyses	30	22	..	24	23
Transverse diameter of prezygapophyses	18	13	..	15	12
Distance across prezygapophyses	60	45	..	48	44
Antero-posterior diameter of postzygapophyses	23	r. 22, l. 24	..	r. 26, l. 22	20
Transverse diameter of postzygapophyses	r. 22, l. 15	r. 14, l. 12	..	14	12
Distance across postzygapophyses	57	42	..	48	42
Vertical diameter of anterior face for head of rib	*20*	20	..	17	15
Horizontal diameter of anterior face for head of rib	*16*	12	..	12	9
Vertical diameter of posterior face for head of rib	27	22	25	*24*	17
Horizontal diameter of posterior face for head of rib	23	19	22	*21*	17
Antero-posterior diameter of face for tubercle of rib	22	17	..	21	15
Vertical diameter of face for tubercle of rib	20	18	..	20	17
Transverse diameter of pedicel	32	20	..	23	20
Antero-posterior diameter of pedicel	37	28	..	35	28
Distance between faces for heads of ribs	28	20	..	20	29
Height of spine from neural canal to extremity	140	..	..	143	98
Antero-posterior diameter of spine above neural canal	40	32	..	38	30
Antero-posterior diameter of spine at top	50	..	..	38	20

The Thirteenth Dorsal Vertebra.

Two specimens representing this bone were found, No. 1604 and No. 1703*C*. Specimen No. 1604 is in almost perfect condition, having sustained practically no injury except of a very minor character on the margin of the right postzygapophysis (see Fig. 58). Specimen No. 1703*C* is likewise a very perfect specimen (see Fig. 59), though slightly malformed as if through the dislocation on the right side of one of the ribs, for which a false attachment has been formed on the side of the centrum below and behind.

The spine of the thirteenth cervical is broad at its upper extremity, flattened, and viewed laterally, produced strongly backward on its upper two-thirds, and also produced forward. In specimen 1604 the prezygapophyses are flattened surfaces lying on either side of the neural canal, their anterior lips almost reaching

the upper margin of the centrum. They look upward and strongly forward. In the other two specimens the prezygapophyses look upward, forward, and outward, but are widely separated from the upper margin of the centrum. The postzygapophyses look backward, downward, and slightly inward, and are advanced backward, being supported by a backward projection from the radix, forming a pedicel for these faces. The transverse process becomes tituberculate, the upper portion immediately in advance of the postzygapophyses extends transversely forward as an elevated ridge of bone, from which about half-way between the postzyga-

FIG. 58. Thirteenth dorsal of *M. elatus* (No. 1604). ×⅓.

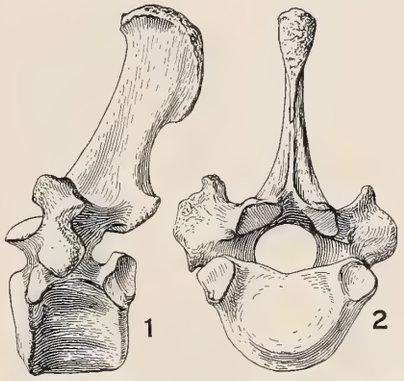


FIG. 59. Thirteenth dorsal of *M. petersoni* (No. 1703*C*). ×⅓. 1, lateral view; 2, posterior view.

pophyses and the articulating face for the tuberculum of the rib a well-defined metapophysis rises, pointing outward and forward. Between this metapophysial projection and the face for the tuberculum of the rib is a somewhat conical process, which projects backward, outward, and upward. The intervertebral foramen is formed by a deep groove running outwardly between the transverse process and the posterior articulating surface for the head of the rib, the upper margin of which closely approaches a spinous projection extending backward from the posterior surface of the radix so as almost to enclose the groove. The articular faces for the heads of the ribs are widely separated, the one in front being small and tending to coalesce with the face for the tubercle of the rib and that behind being fully three times as large as that in front.

MEASUREMENTS OF THIRTEENTH DORSAL VERTEBRA.[36]

	1604, mm.	1703*C*, mm.
Greatest height from base of centrum to top of spine	210	155
Greatest transverse diameter measured across transverse processes	116	96
Greatest antero-posterior diameter measured from front of prezygapophyses to back of postzygapophyses	84	68
Length of centrum along floor of neural canal	55	43
Length of centrum along inferior surface	49	38
Vertical diameter of anterior face of centrum	55	40
Transverse diameter of anterior face of centrum	67	46
Vertical diameter of posterior face of centrum	62	42
Transverse diameter of posterior face of centrum	98	75
Vertical diameter of neural canal	25	21
Transverse diameter of neural canal	27	21
Antero-posterior diameter of prezygapophyses	27	r. 20, l. 22
Transverse diameter of prezygapophyses	15	13
Distance across prezygapophyses	55	44
Antero-posterior diameter of postzygapophyses	r. 25, l. 16	26
Transverse diameter of postzygapophyses	r. 20, l. 13	16
Distance across postzygapophyses	56	42
Vertical diameter of anterior face for head of rib	17	17
Horizontal diameter of anterior face for head of rib	16	11
Vertical diameter of posterior face for head of rib	26	19
Horizontal diameter of posterior face for head of rib	22	16
Antero-posterior diameter of face for tubercle of rib	23	14
Vertical diameter of face for tubercle of ribs	35	15
Transverse diameter of pedicel	28	19
Antero-posterior diameter of pedicel	38	32
Distance between faces for heads of ribs	30	23
Height of spine from neural canal to extremity	135	105
Antero-posterior diameter of spine above neural canal	44	38
Antero-posterior diameter of spine at top below tubercular enlargement	57	34
Height of metapophysis above upper margin of prezygapophysis	29	19

The Fourteenth Dorsal Vertebra.

Three specimens of the fourteenth dorsal vertebra of *Moropus* were discovered, No. 1604, No. 1703*C*, and No. 1713. No. 1604 is an almost perfect bone, having only sustained some slight injuries on the posterior articulating face of the centrum through crushing, and the faces of the postzygapophyses and the upper extremity of the spine having been very slightly injured (see Fig. 60). No. 1703*C* is practically perfect, requiring no repair (see Fig. 61). No. 1713 is also perfect, except that it has lost the anterior and posterior epiphyses of the centrum.

[36] Numbers in italics represent approximate measurements.

The spine in this vertebra is of practically the same height as in the vertebra preceding and following it. It is compressed and flattened out in its upper half, viewed laterally, the posterior margin being very strongly produced backward and the anterior margin being strongly produced forward. Its upper extremity and the backward enlargement above are thickened and roughened in order to support

Fig. 60. Fourteenth dorsal of *M. elatus* (No. 1604). $\times\frac{1}{3}$.

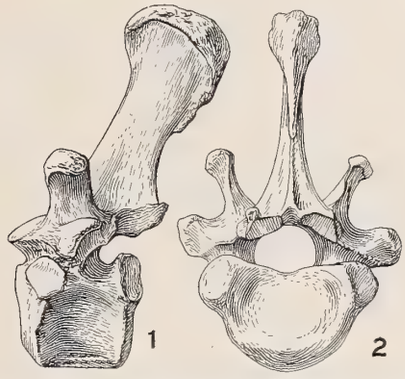


Fig. 61. Fourteenth dorsal of *M. petersoni* (No. 1703*C*). $\times\frac{1}{3}$. 1, lateral view; 2, posterior view.

strong ligamentary attachments. This is very noticeable in specimens No. 1604 and No. 1703*C*. The prezygapophyses are reduced in size in specimen No. 1604, looking upward and strongly forward, their anterior extremities separated from the upper margin of the centrum by a shallow groove. In the other two specimens the anterior extremities of the prezygapophyses are much more widely separated from the anterior margin of the centrum. The postzygapophyses in all three specimens look backward, downward, slightly inward, and are supported upon peduncular backward prolongations formed at the point of union of the laminæ and the contiguous portion of the radix. From these peduncular projections an elevated ridge of bone runs directly forward, and at about its middle the apophysis rises upward pointing slightly forward and outward. The height of the metapophysis in this vertebra is fully twice that of the height of the corresponding process in the 13th dorsal. Between the origin of the spine and the metapophysis there is a deep depression. The transverse process extends outward and backward, viewed laterally, having its outward extremity somewhat lunate in form. There is no articulating surface upon this process, the tubercle of the fourteenth rib being only indicated by a slight swelling. The articulating faces for the heads

of the ribs are very widely separated, the anterior face looking outward, downward, and slightly forward. The posterior articulating face for the head of the rib is carried upon a rugose protuberance located back of the opening for the intervertebral foramen. This face looks backward, outward, and slightly upward. In vertical cross-section the centrum of this vertebra as well as of those immediately preceding it from the eighth backward is subtriangular. This is true also of the succeeding vertebra and of the first three lumbars; less distinctly true, however, of the three posterior lumbar vertebræ, which in cross-section become oval.

MEASUREMENTS OF FOURTEENTH DORSAL VERTEBRA.[37]

	1604, mm.	1703*C*, mm.	1715, mm.
Greatest height from base of centrum to top of spine	217	161	190
Greatest transverse diameter measured across transverse processes	124	95	112
Greatest antero-posterior diameter measured from front of prezygapophyses to back of postzygapophyses	84	69	82
Length of centrum along floor of neural canal	53	44	*50*
Length of centrum along inferior surface	46	36	*35*
Vertical diameter of anterior face of centrum	60	40	*48*
Transverse diameter of anterior face of centrum	64	48	*48*
Vertical diameter of posterior face of centrum	67	44	*50*
Transverse diameter of posterior face of centrum	97	78	*90*
Vertical diameter of neural canal	25	20	20
Transverse diameter of neural canal	27	23	22
Antero-posterior diameter of prezygapophyses	r. 25, l. ..	r. 20, l. 23	23
Transverse diameter of prezygapophyses	r. 17, l. ..	r. 10, l. 12	15
Distance across prezygapophyses	*54*	40	48
Antero-posterior diameter of postzygapophyses	22	22	r. 25, l. 29
Transverse diameter of postzygapophyses	r. 17, l. 11	13	r. 17, l. 18
Distance across postzygapophyses	57	40	47
Vertical diameter of anterior face for head of rib	23	20	20
Horizontal diameter of anterior face for head of rib	20	17	*16*
Vertical diameter of posterior face for head of rib	*28*	17	*26*
Horizontal diameter of posterior face for head of rib	*14*	15	20
Transverse diameter of pedicel above transverse process	20	16	23
Antero-posterior diameter of pedicel	35	30	35
Distance between posterior faces for heads of ribs	37	27	30
Height of spine from neural canal to extremity	144	110	135
Antero-posterior diameter of spine above neural canal	42	35	40
Antero-posterior diameter of spine at top	50	40	40
Height of metapophysis above upper margin of prezygapophysis	40	31	37

[37] Numbers in italics indicate approximate measurements.

The Fifteenth Dorsal Vertebra.

Five specimens of the fifteenth dorsal were recovered, No. 1604, No. 1703*C*, No. 1708, No. 1713, and No. 1715. In the fifteenth dorsal a profound modification takes place in order to adapt it to union with the succeeding lumbar series. The articulating surfaces of the postzygapophyses look outward and downward, are convex, and are supported upon the posterior surfaces of the laminæ, which divide on either side of the neural arch and project far backward, overhanging the posterior articulating face of the centrum. The metapophysis is greatly lengthened, the transverse process projects strongly outward. There is but one articulating facet for the head of the rib on the anterior face of the centrum. The specimen No. 1604 is in almost perfect condition and together with the fragment of No. 1708, as will be pointed out later, presents very remarkable differences from the other three specimens. No. 1703*C* is also an almost perfect specimen, the extremity of the right metapophysis alone having been slightly injured and requiring minor repairs. No. 1708 consists of a large centrum with pre- and

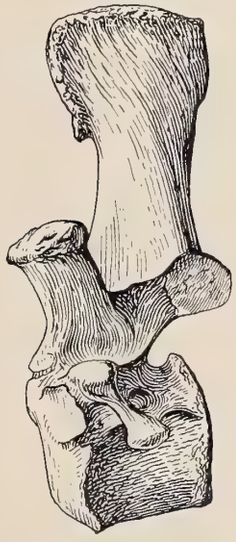


FIG. 62. Fifteenth dorsal of *M. elatus* (No. 1604). $\times\frac{1}{3}$.

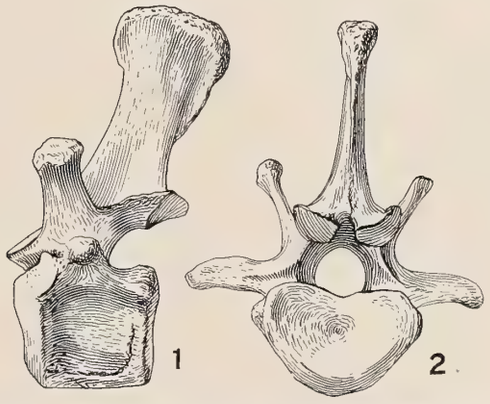


FIG. 63. Fifteenth dorsal of *M. petersoni* (No. 1703*C*). $\times\frac{1}{3}$. 1, lateral view; 2, posterior view.

postzygapophyses and the neural arch crushed down upon the centrum. Specimen No. 1713 has lost the right metapophysis and the outer extremity of the transverse process on the same side. The bone is slightly distorted, the distortion having apparently taken place during the life of the individual. The right postzygapophysis is lower than the left and has been crushed inwardly, showing that the individual to which it belonged had sustained spinal injuries. The posterior

epiphysis of the centrum is also missing. Specimen No. 1715 is a remarkably perfect little specimen, having sustained practically no injury whatever, all the processes and the articulating surfaces being well preserved.

The dorsal spine in this vertebra is flattened. Viewed laterally, it projects strongly forward at its upper end, less prominently on its posterior margin. It is thickened transversely at its upper extremity and is rugose. The laminæ posteriorly strongly overhang the centrum, and the postzygapophyses look outward, downward, and slightly backward. They are connected with the metapophysis by a narrow elevated ridge of bone between which and the anterior point of union of the laminæ is a deep cavity lying between the spine and the metapophysis. The transverse process in specimen No. 1604 is formed by a process extending horizontally from the upper surface of the centrum and by a process arising from the side of the centrum less than one-third of the distance from its upper surface, which projects horizontally outward and backward. These two projections are united near their extremities by an outward narrow lamella or bridge of bone, which is directed obliquely backward and downward from the lower surface of the upper process and continued backward as an oblique process, pointing backward and outward. The arch formed by the union of these three encloses a large foramen which apparently accommodated a branch of the nerve passing out through the vertebral foramen (see Fig. 62). The same structure is found in the broken centrum of specimen No. 1708. No trace of such an arrangement is to be found in specimens Nos. 1703*C*, 1713, and 1715, the transverse process in all of these being a blunt narrow spine (see Fig. 63). The writer is inclined to regard this remarkable modification of the transverse process as indicating among other things a specific difference, and it is employed by him as one of the diacritic points of distinction between *Moropus elatus* Marsh and *Moropus petersoni* Holland. The prezygapophyses in all of the specimens look upward and somewhat strongly forward, but in specimens Nos. 1604 and 1708 they look far more strongly forward than in any of the other specimens. Their anterior extremities in Nos. 1604 and 1708 are almost contiguous with the upper margin of the centrum, from which they are only separated by a very narrow groove, whereas in the other three specimens there is relatively a great distance between their upper extremities and the upper margin of the centrum, which they also overhang. In specimen No. 1604 the prezygapophyses do not overhang the centrum, but their anterior extremities are located slightly behind the anterior margin; in specimen No. 1708 this feature is not so strongly marked.

MEASUREMENTS OF FIFTEENTH DORSAL VERTEBRA.[38]

	1604, mm.	1703*C*, mm.	1708, mm.	1713, mm.	1715, mm.
Greatest height from base of centrum to top of spine	212	155	..	200	132
Greatest transverse diameter measured across transverse processes	150	120	..	*134*[39]	107
Greatest antero-posterior diameter measured from front of prezygapophyses to back of postzygapophyses	92	81	*95*	71	70
Length of centrum along floor of neural canal	62	52	62	*52*	45
Length of centrum along inferior surface	48	40	50	*42*	35
Vertical diameter of anterior face of centrum	61	44	61	50	40
Transverse diameter of anterior face of centrum	68	52	70	55	50
Vertical diameter of posterior face of centrum	63	42	63	*52*	40
Transverse diameter of posterior face of centrum	88	65	*80*	*82*	62
Vertical diameter of neural canal	22	21	21	21	22
Transverse diameter of neural canal	27	22	22	23	21
Transverse diameter of prezygapophyses	r. 17, l. 15	r. 13, l. 15	21	r. 10, l. 16	r. 12, l. 16
Antero-posterior diameter of prezygapophyses	25	r. 22, l. 18	30	26	16
Distance across prezygapophyses	67	38	62	50	48
Antero-posterior diameter of postzygapophyses	r. 27, l. 21	r. 24, l. 22	28	r. 30, l. 25	20
Transverse diameter of postzygapophyses	26	22	*30*	r. 30, l. 25	20
Distance across postzygapophyses above	62	42	..	*47*	42
Vertical diameter of anterior face for head of rib	23	18	22	21	14
Horizontal diameter of anterior face for head of rib	20	14	20	16	14
Transverse diameter of pedicel above transverse process	14	12	18	14	14
Antero-posterior diameter of pedicel	42	30	*45*	37	25
Distance between anterior face for head of rib and posterior margin	50	40	46	*38*	34
Height of spine from neural canal to extremity	130	111	..	137	90
Antero-posterior diameter of spine above neural canal	46	35	..	42	32
Antero-posterior diameter of spine at top, approximate	62	45	..	43	30
Height of metapophysis above prezygapophysis	48	36	..	42	32

The Lumbar Vertebræ.

Four series of lumbar vertebræ in more or less perfect condition were recovered. In the case of No. 1604, the mounted specimen, the last three lumbars were missing, but specimen No. 1708 provided six centra of a specimen of almost identically the same size and undoubtedly belonging to the same species, which were found lying collocated in such a manner as not to leave any doubt that they belonged to one individual. The centra of three of these specimens, the last of which preserved the

[38] Figures in italics denote approximate measurements.

[39] Obtained by measuring from middle of neural canal to end of left transverse process and multiplying by 2. The right transverse process is broken off at the tip.

neural arch and a considerable portion of the spine, were utilized in restoring the last three vertebræ of the series. The lumbar series in the mounted specimen consists therefore of the three anterior lumbars belonging to No. 1604 and the last three centra of No. 1708. No. 1703*C* is a series of six lumbar vertebræ which were found in the same locality and which are discovered to exactly fit each other, so as to leave hardly any room whatever for doubt that they belonged to the same individual. Specimen No. 1713 also supplied a series of six lumbar vertebræ very well preserved in all respects, except that they have all lost the anterior and posterior epiphyses of the centra.

In addition to the four series above mentioned a number of other lumbar vertebræ not forming a series were discovered. Their dimensions will be given.

The spines of the lumbar vertebræ when they are arranged in regular serial order in all cases describe a gentle curve rising from the first to the fifth vertebra and then declining so as to coincide approximately in height with the extremities of the sacral vertebræ. The spines, viewed laterally, are greatly flattened in an antero-posterior direction, strongly rugose at their upper extremities, and vertical in position. The metapophyses are broad, projecting upward and forward. The transverse processes are broad, flattened, projecting horizontally outward, except in the case of the last lumbar, which is considerably thickened and projects somewhat forward, to conform with the anterior margin of the ilium. The centra of the first four lumbars in vertical section are more or less subtriangular, the last two are greatly flattened and compressed vertically and more or less oval in cross-section, thus approximating in outline the form of the centra in the sacral vertebræ, which are likewise greatly compressed vertically. The prezygapophyses are formed on the anterior face of the upturned margin of the laminæ below the point where the metapophyses have their origin, are concave, and look upward, inward, and forward. The postzygapophyses are laterally convex, look downward, outward, and backward and greatly overhang the posterior face of the centrum.

First Lumbar Vertebra.

Seven specimens of the first lumbar were found. Of these No. 1703*C* is referred to *M. petersoni*, the others to *M. elatus*. No. 1604 belongs to the mounted specimen and is in an excellent state of preservation (see Fig. 64). No. 1708 is a centrum preserving with it portions of the neural arch and the right metapophysis and transverse process. Specimens No. 1604 and No. 1708 pertain to old and fully adult specimens of *M. elatus*. No. 1713 is the first lumbar of a large but not fully matured specimen, the epiphyses of the centrum having been lost. Nos.

1714, 1714*A*, and 1714*B* are small and very immature specimens in a more or less damaged condition.

The spine of the first lumbar is broad, flattened, and projects forward on its upper anterior margin. Its extremity is thickened transversely and is rugose. The metapophyses in *Moropus elatus* diminish in the antero-posterior diameter of their extremities and are subtriangular in outline, while in *Moropus petersoni*

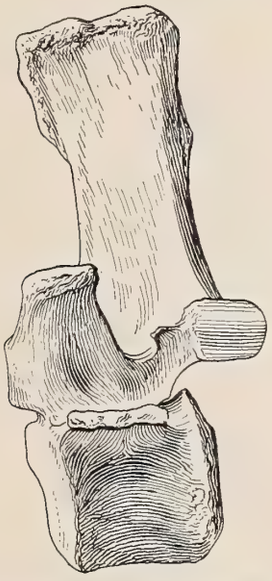


Fig. 64. First lumbar of *M. elatus* (No. 1604). ×⅓.

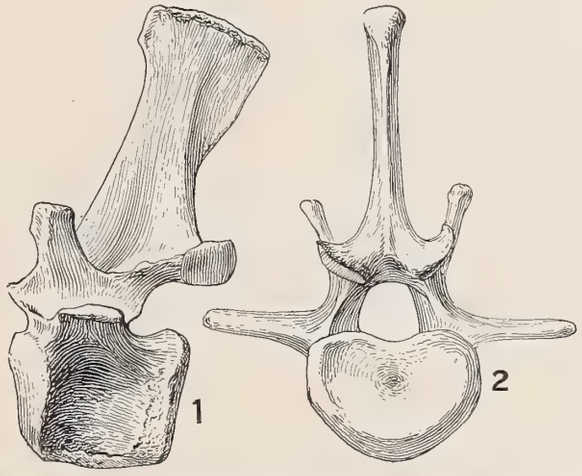


Fig. 65. First lumbar of *M. petersoni* (No. 1703*C*). ×⅓. 1, lateral view; 2, posterior view.

they do not thus rapidly diminish but are almost as wide at their ends as at their origins. The prezygapophysial surfaces occupy the lower anterior half of the inner face of the metapophyses in adult specimens of *Moropus elatus*, and in immature specimens a relatively larger proportion of the surface, the metapophysis in immature specimens being shorter, while the articulating surface is relatively large. In *Moropus petersoni* the prezygapophysial surface is principally supported on the radix and does not impinge greatly upon the inner surface of the metapophysis. The first lumbar in *M. petersoni* has, in fact, a prezygapophysis which in its form and arrangement is much like that of the dorsals (see Fig. 65). The postzygapophyses greatly overhang the posterior face of the centrum. The centrum is subtriangular in vertical section at the middle and at both ends. The transverse processes are wide, flattened, horizontal spines, which in *M. elatus* rake slightly backward, but in *M. petersoni* are directed outward at right angles to the axis of the vertebra.

Measurements of First Lumbar Vertebra.[40]

	1604, mm.	1703*C*, mm.	1708, mm.	1713, mm.	1714*A*, mm.	1714*B*, mm.	1714*C*, mm.
Greatest height from base of centrum to top of spine	230	173	..	203	145	149	148
Greatest transverse diameter measured across transverse processes	176	134	..	*135*	124	...	130
Greatest antero-posterior diameter measured from front of prezygapophyses to back of postzygapophyses	110	84	..	104	...	*75*	80
Length of centrum along floor of neural canal	66	58	60	*50*	*40*	*40*	*42*
Length of centrum along inferior surface	51	45	55	*42*	*32*	*32*	*34*
Vertical diameter of anterior face of centrum	62	43	60	*52*	42	*40*	*35*
Transverse diameter of anterior face of centrum	80	55	70	*63*	52	*52*	*52*
Vertical diameter of posterior face of centrum	70	45	56	*57*	42	*42*	*42*
Transverse diameter of posterior face of centrum	86	64	82	*76*	58	*57*	62
Vertical diameter of neural canal	23	22	22	22	22	22	22
Transverse diameter of neural canal	23	22	20	22	22	22	24
Antero-posterior diameter of prezygapophysial surfaces	26	28	30	25	18	18	20
Transverse diameter of prezygapophysial surfaces	26	21	30	32	25	*24*	24
Distance between prezygapophysial surfaces above	62	45	*55*	*50*	58	*56*	*54*
Antero-posterior diameter of postzygapophyses	29	20	..	30	..	*16*	16
Perpendicular diameter of postzygapophyses	35	25	..	22	..	*17*	20
Distance across postzygapophyses above	42	48	..	42	..	*40*	50
Transverse diameter of pedicel above transverse process	15	11	15	16	9	11	11
Antero-posterior diameter of pedicel	55	33	45	42	33	34	37
Height of spine from neural canal to extremity	153	116	..	140	81	95	95
Antero-posterior diameter of spine above neural canal	70	46	..	48	..	37	38
Antero-posterior diameter of spine at top	70	42	..	50	31	28	33
Height of metapophysis above prezygapophysial surfaces	32	30	..	28	*2*	..	*10*
Height of metapophysis above transverse process	60	43	..	57	*38*	*36*	*40*
Antero-posterior diameter of metapophysis below	45	25	..	42	25	30	30
Antero-posterior diameter of metapophysis at end	18	10	..	22	..	..	..
Distance across ends of metapophyses	108	72	..	90	*70*	*68*	*72*

The Second Lumbar Vertebra.

The second lumbar vertebra of No. 1604 was found in almost perfect condition. Four other second lumbars were recovered. Of these specimens No. 1703*C* is quite perfect. No. 1708 is a centrum preserving the outline of the neural arch, though without any of the lateral and superior processes. No. 1713 is practically perfect except for the loss of the anterior and posterior epiphyses of the centrum and the transverse processes at their ends. No. 1714*D* has lost the epiphyses of the centrum, the greater portion of the dorsal spine, both transverse processes, and the end of the metapophysis of the left side.

[40] Numbers in italics indicate approximate measurements.

The second lumbar vertebra is characterized by the backward and outward slope of the extremity of the mammillary process or metapophysis, which is more strongly marked in *Moropus elatus* than in *Moropus petersoni*. The articulating surfaces for the postzygapophyses of the first lumbar occupy more than half of

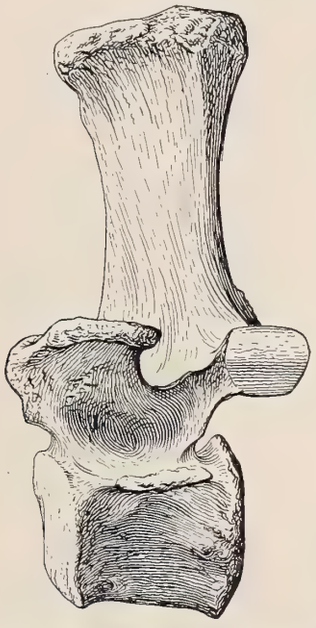


Fig. 66. Second lumbar of *M. elatus* (No. 1604). ×⅓.

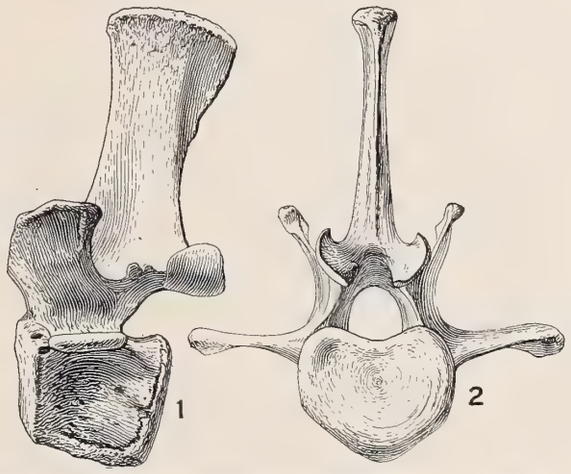


Fig. 67. Second lumbar of *M. petersoni* (No. 1703*C*). ×⅓. 1, lateral view; 2, posterior view.

the inner surface of the metapophysis measured vertically. The spine corresponds in general outline with the preceding vertebra, except that at its upper extremity it is not as strongly produced forward, and is relatively longer. The transverse processes in *Moropus elatus* are directed somewhat more backward than in *Moropus petersoni*, which they otherwise closely resemble in structure. The centrum is subtriangular in cross-section at its middle.

Measurements of Second Lumbar Vertebra.[41]

	1604, mm.	1703*C*, mm.	1708, mm.	1713, mm.	1714*D*, mm.
Greatest height from base of centrum to top of spine	248	186	..	210	..
Greatest transverse diameter measured across transverse processes	200	152	..	...	..
Greatest antero-posterior diameter measured from front of prezygapophyses to back of postzygapophyses	125	96	..	110	82
Length of centrum along floor of neural canal	78	57	66	*50*	*43*
Length of centrum along inferior surface	61	50	51	*40*	*35*
Vertical diameter of anterior face of centrum	64	47	61	*52*	*40*

[41] Numbers in italics denote approximate measurements.

Transverse diameter of anterior face of centrum	75	59	73	*67*	*50*
Vertical diameter of posterior face of centrum	70	48	65	*55*	*40*
Vertical diameter of neural canal	25	22	22	22	20
Transverse diameter of neural canal	23	22	..	22	20
Antero-posterior diameter of prezygapophysial surfaces	39	22	..	27	20
Vertical diameter of prezygapophysial surfaces	37	26	..	29	22
Distance between prezygapophysial surfaces above	46	47	..	44	25
Antero-posterior diameter of postzygapophyses	37	24	..	30	21
Perpendicular diameter of postzygapophyses	30	23	..	26	21
Distance across postzygapophyses above	50	40	..	44	35
Transverse diameter of pedicel	16	13	19	16	11
Antero-posterior diameter of pedicel	60	39	52	51	35
Height of spine from neural canal to extremity	168	120	..	145	..
Antero-posterior diameter of spine above neural canal	68	52	..	50	40
Antero-posterior diameter of spine at top	62	50	..	*50*	..
Height of metapophysis above prezygapophysial surface	20	15	..	20	10
Height of end of metapophysis above transverse process	60	52	..	50	42
Antero-posterior diameter of metapophysis below	45	35	..	42	29
Antero-posterior diameter of metapophysis at end	28	17	..	21	22
Distance across ends of metapophyses	120	83	..	95	78

The Third Lumbar Vertebra.

Four examples of the third lumbar vertebra have been made the subjects of careful study and measurement. The largest of these is No. 1604, representing *M. elatus*, and belongs to the mounted specimen (see Fig. 68). It has sustained some injuries on the upper anterior edge of the dorsal spine, and at the ends of the metapophyses and transverse processes, but in no case are these so extensive as to make accurate measurements in most dimensions impossible. The specimen is practically perfect. No. 1703*C* is likewise an excellent specimen, belonging to *M. petersoni*, which has only required some minor repairs on the left postzygapophysis and at the ends of the transverse processes, which were a little broken (see Fig. 69). No. 1708 is the centrum of a specimen of *M. elatus* hardly inferior in size to No. 1604. It preserves the neural arch, both pedicels, and the left postzygapophysis; all the other superior processes have been lost, or badly broken. No. 1713 is a specimen of the third lumbar of a large but immature individual of *M. elatus*. The vertebra is perfect except for the loss of the end of the left transverse process, and the epiphyses of the centrum.

The third lumbar in *M. elatus* is characterized by having the anterior edge of the dorsal spine above well produced forward; in *M. petersoni* the edges of the extremity of the spine are produced antero-posteriorly both before and behind. The spine is longer than in the second lumbar. The prezygapophysial surfaces

occupy fully two-thirds of the vertical height of the inner side of the metapophysis above the neural canal. The upper end of the metapophysis (mammillary process)

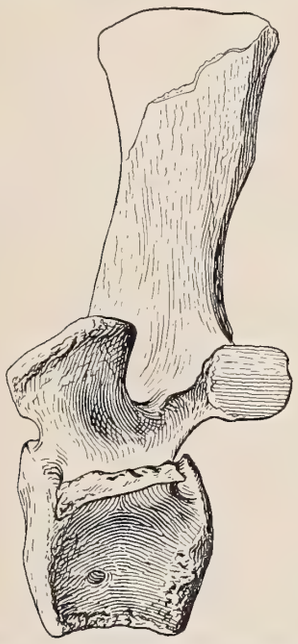


FIG. 68. Third lumbar of *M. elatus* (No. 1604). ×⅓.

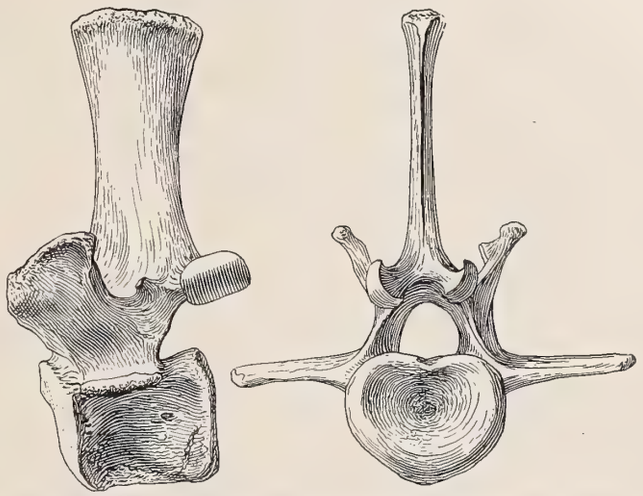


FIG. 69. Third lumbar vertebra of *M. petersoni* (No. 1703*C*). ×⅓.

is directed backward. The centrum in cross-section at the middle is subtriangular. In other respects this member of the lumbar series resembles the two vertebræ preceding it.

MEASUREMENTS OF THIRD LUMBAR VERTEBRA.[42]

	1604, mm.	1703*C*, mm.	1708, mm.	1713, mm.
Greatest height from base of centrum to top of spine	260	197	..	235
Greatest transverse diameter measured across transverse processes	216	168	..	*196*
Greatest antero-posterior diameter measured from front of prezygapophyses to back of postzygapophyses	135	97	..	104
Length of centrum along floor of neural canal	68	60	69	*67*
Length of centrum along inferior surface	52	48	54	*46*
Vertical diameter of anterior face of centrum	77	52	75	*61*
Transverse diameter of anterior face of centrum	85	60	*78*	*72*
Vertical diameter of posterior face of centrum	75	50	*70*	*58*
Transverse diameter of posterior face of centrum	93	67	*85*	*85*
Vertical diameter of neural canal	24	24	*25*	25
Transverse diameter of neural canal	24	25	*27*	25
Antero-posterior diameter of prezygapophysial surfaces	46	27	..	30
Vertical diameter of prezygapophysial surfaces	40	27	..	35

[42] Figures in italics are approximate measurements.

Distance between prezygapophysial surfaces above	50	46	..	42
Antero-posterior diameter of postzygapophyses	34	25	30	28
Vertical diameter of postzygapophyses	31	21	34	30
Distance across postzygapophyses above	42	40	56	48
Transverse diameter of pedicel	15	14	*16*	15
Antero-posterior diameter of pedicel	55	44	50	52
Height of spine from neural canal to extremity	172	136	..	156
Antero-posterior diameter of spine above neural canal	67	53	..	59
Antero-posterior diameter of spine at top	*64*	50	..	55
Height of metapophysis above prezygapophysial faces	15	13	..	14
Height of metapophysis above transverse process	65	51	..	65
Antero-posterior diameter of metapophysis below	42	34	38	36
Antero-posterior diameter of metapophysis at end	25	22	..	22
Distance across ends of metapophyses	114	77	..	100

The Fourth Lumbar Vertebra.

Four specimens representing the fourth lumbar vertebra have been made the subject of study. The fourth lumbar of the mounted specimen was missing. The centrum of specimen No. 1708, an individual of very nearly the same size as specimen No. 1604, was therefore selected as the basis for the restoration. It retains in addition to the centrum the bases of the transverse processes, the origins of the metapophyses, and the greater part of the neural arch. With the other excellently preserved specimens before him Mr. Peterson was able readily to effect a restoration which fulfills all requirements. Specimen No. 1703*C* representing *M. petersoni* is practically perfect, except that it has lost the extremity of the right postzygapophysis which has been restored (see Fig. 70). Specimen No.

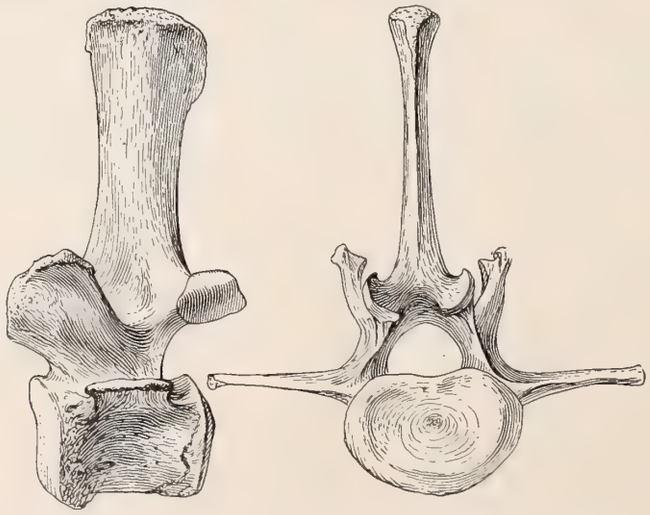


Fig. 70. Fourth lumbar vertebra of *M. petersoni* (No. 1703*C*). $\times\frac{1}{3}$.

1713 is that of a large, but immature, individual of *M. elatus*, which is practically perfect, except for the loss of the anterior and posterior epiphyses of the centrum. Specimen No. 1731 is the centrum of a comparatively small individual probably belonging to *M. petersoni*. All of the superior structures have been lost and only the bases of the transverse processes remain adherent.

The fourth lumbar vertebra is characterized by having the anterior articulating face of the centrum subtriangular while the posterior face is vertically compressed, tending to become oval in outline, thus marking the beginning of the accommodation of the form of the centra of the lumbars for adjustment to the centra of the sacral series. The spine is greatly thickened and widened antero-posteriorly at its extremity and is slightly longer than that of the third lumbar, thus marking the highest point of the slight curve described by the extremities of the lumbars. The spine inclines very slightly backward. The prezygapophysial surfaces occupy nearly three-fourths of the anterior margin of the inner surface of the metapophyses.

MEASUREMENTS OF FOURTH LUMBAR VERTEBRA.[43]

	1708, mm.	1703*C*, mm.	1713, mm.	1731, mm.
Greatest height from base of centrum to top of spine	*263*	198	230	..
Greatest transverse diameter measured across transverse processes	*230*	171	182	..
Greatest antero-posterior diameter measured from front of prezygapophyses to back of postzygapophyses	*128*	99	105	..
Length of centrum along floor of neural canal	70	64	*63*	65
Length of centrum along inferior surface	62	54	*52*	55
Vertical diameter of anterior face of centrum	66	50	*55*	45
Transverse diameter of anterior face of centrum	77	65	*72*	64
Vertical diameter of posterior face of centrum	60	50	*63*	50
Transverse diameter of posterior face of centrum	93	72	*77*	74
Vertical diameter of neural canal	*25*	25	25	..
Transverse diameter of neural canal	*25*	30	25	..
Antero-posterior diameter of prezygapophysial surfaces	*35*	25	32	..
Vertical diameter of prezygapophysial surfaces	*43*	27	32	..
Distance between prezygapophysial surfaces above	*50*	40	43	..
Antero-posterior diameter of postzygapophyses	*38*	25	32	..
Vertical diameter of postzygapophyses	*32*	20	27	..
Distance across postzygapophyses above	*50*	*37*	43	..
Transverse diameter of pedicel	19	15	15	*16*
Antero-posterior diameter of pedicel	56	44	49	*47*
Height of spine from neural canal to extremity	*181*	140	150	..
Antero-posterior diameter of spine above neural canal	*68*	50	56	..
Antero-posterior diameter of spine at top	*67*	45	59	..

[43] Numbers in italics denote approximate measurements, the specimens being restored or broken.

Height of metapophysis above prezygapophysial face	*12*	13	19	..
Height of metapophysis above transverse process	*75*	54	58	..
Antero-posterior diameter of metapophysis below	*45*	32	35	..
Antero-posterior diameter of metapophysis at end	*30*	22	27	..
Distance across ends of metapophyses	*112*	74	105	..

The Fifth Lumbar Vertebra.

In effecting a restoration of the mounted skeleton the centrum of the fifth lumbar vertebra belonging to specimen No. 1708 was employed. The centrum in this case was slightly injured on its anterior and posterior surfaces below and only retained the bases of the transverse processes and some portions of the pedicels. In the light of more perfect material, however, a satisfactory restoration was possible. No. 1703*C* is a practically perfect specimen (see Fig. 71), having only

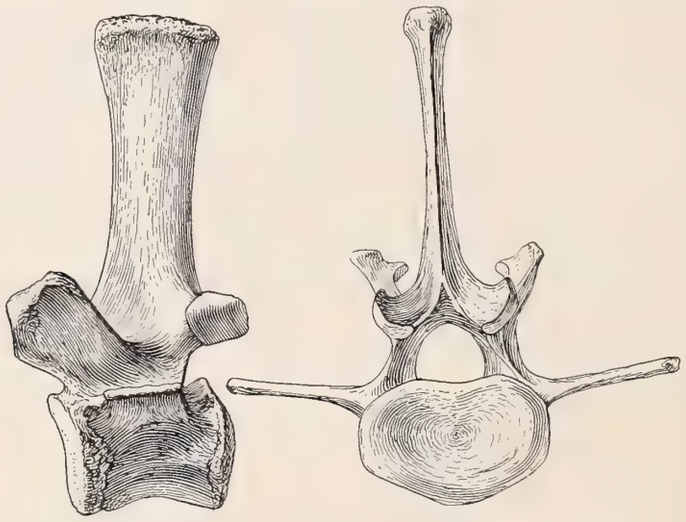


Fig. 71. Fifth lumbar vertebra of *M. petersoni* (No. 1703*C*). $\times\frac{1}{3}$.

sustained a few minor injuries at the extremities of the transverse processes. Specimen No. 1713 is likewise a perfect specimen except for the loss of the anterior epiphysis of the centrum; the posterior epiphysis remains. Specimen No. 1714*A* represents a small and immature individual probably belonging, as does also specimen No. 1703*C*, to *M. petersoni*. The immaturity of specimen No. 1714*A* is shown by the loss of the anterior and posterior epiphyses of the centrum. The left metapophysis has been lost and the extremity of the left transverse process has sustained considerable injury. In other respects the specimen is quite perfect.

In studying the specimens of the fifth lumbar it is noticeable that the anterior and posterior articulating surfaces of the centrum have become greatly compressed

vertically. The transverse diameter of the posterior face is greater than that of the anterior face. The outline of the anterior face is very bluntly cordate; of the posterior face transversely elongated oval. The spine inclines backward somewhat more than is the case in the fourth lumbar, and is somewhat shorter than in that vertebra. It is greatly thickened at its extremity and widened antero-posteriorly. The backward inclination of the spine is greater in *M. petersoni* than in *M. elatus*.

Measurements of Fifth Lumbar Vertebra.[44]

	1708, mm.	1703*C*, mm.	1713, mm.	1714*A*, mm.
Greatest height from base of centrum to top of spine	*263*	201	240	145
Greatest transverse diameter measured across transverse processes	*225*	184	210	*130*
Greatest antero-posterior diameter measured from front of prezygapophyses to back of postzygapophyses	*125*	105	105	70
Length of centrum along floor of neural canal	*75*	62	*67*	*45*
Length of centrum along inferior surface	*60*	56	*60*	*38*
Vertical diameter of anterior face of centrum	*57*	44	55	40
Transverse diameter of anterior face of centrum	*88*	67	78	58
Vertical diameter of posterior face of centrum	*65*	49	60	38
Transverse diameter of posterior face of centrum	*105*	79	98	64
Vertical diameter of neural canal	*25*	25	26	24
Transverse diameter of neural canal	*32*	31	31	27
Antero-posterior diameter of prezygapophysial surfaces	*38*	26	35	17
Vertical diameter of prezygapophysial surfaces	*38*	27	37	20
Distances between prezygapophysial surfaces above	*58*	35	50	*48*
Antero-posterior diameter of postzygapophyses	*33*	23	26	17
Vertical diameter of postzygapophyses	*31*	20	34	22
Distance across postzygapophyses above	*55*	54	54	42
Transverse diameter of pedicel	18	12	15	10
Antero-posterior diameter of pedicel	52	47	46	35
Height of spine from neural canal to extremity	*180*	142	163	75
Antero-posterior diameter of spine above neural canal	*65*	48	60	38
Antero-posterior diameter of spine at top	*48*	42	56	34
Height of metapophysis above prezygapophysial face	*15*	10	12	*8*
Height of metapophysis above transverse process	*75*	55	63	41
Antero-posterior diameter of metapophysis below	*52*	29	35	25
Antero-posterior diameter of metapophysis (mammillary) at end	*30*	15	22	16
Distance across ends of metapophyses	*120*	75	107	70

The Sixth Lumbar Vertebra.

Specimen No. 1708 was again resorted to in furnishing material for a restoration to be used in connection with the mounted specimen. Fortunately the centrum of this specimen was well preserved with the exception of the extremities

[44] Figures in italics denote approximate measurements, the specimens having been restored or broken.

of the transverse processes and metapophyses and some of the upper portions of the spine. Specimen No. 1703*C* is practically perfect except for the loss of the extremity of the right postzygapophysis and a fragment at the end of the spine (see Fig. 72). Specimen No. 1713 is a practically perfect specimen except for the

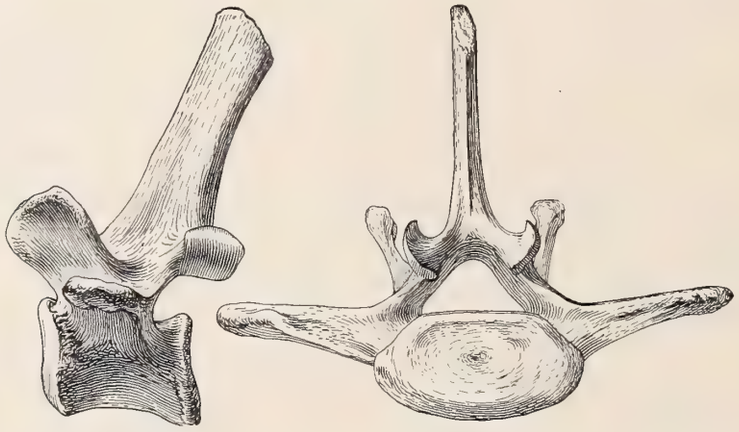


FIG. 72. Lateral and posterior views of the sixth lumbar of *M. petersoni* (No. 1703*C*). $\times\frac{1}{3}$.

loss of the anterior and posterior epiphyses of the centrum. Specimen No. 1731 is a centrum which preserves the bases of the transverse processes and the outline of the pedicels.

The sixth lumbar vertebra is characterized by the vertical compression of the centrum, both the anterior and posterior articulating faces of which are transversely elongated ovals in outline, the posterior face more elongated than the anterior face. The transverse processes are greatly produced, relatively narrower than in the preceding vertebræ, and project slightly forward. At their outward extremities they are obliquely truncated behind, so as to adapt them to the anterior margins of the ilia, with which there is evidence that they had ligamentary attachments. The spine is relatively shorter than in the preceding vertebræ and slopes backward to conform with the slope of the succeeding sacral vertebræ. This slope is more marked in specimen No. 1703*C*, referred to *M. petersoni*, than in the other specimens, which are referred to *M. elatus*.

MEASUREMENTS OF SIXTH LUMBAR VERTEBRA.[45]

	1708, mm.	1703*C*, mm.	1713, mm.	1731, mm.
Greatest height from base of centrum to top of spine	*245*	242	242	..
Greatest transverse diameter measured across transverse processes	*242*	240	240	..
Greatest antero-posterior diameter measured from front of prezygapophyses to back of postzygapophyses	*115*	111	107	..

[45] Numbers in italics denote approximate measurements, the specimens being restored or broken.

Length of centrum along floor of neural canal	65	62	*62*	70
Length of centrum along inferior surface	62	60	*54*	50
Vertical diameter of anterior face of centrum	57	43	52	57
Transverse diameter of anterior face of centrum	107	78	87	80
Vertical diameter of posterior face of centrum	58	45	53	60
Transverse diameter of posterior face of centrum	112	85	100	93
Vertical diameter of neural canal	27	25	27	..
Transverse diameter of neural canal	40	36	33	..
Antero-posterior diameter of prezygapophysial surfaces	*34*	25	29	..
Vertical diameter of prezygapophysial surfaces	*40*	27	38	..
Distance between prezygapophysial surfaces above	*52*	55	57	..
Antero-posterior diameter of postzygapophyses	30	25	31	..
Vertical diameter of postzygapophyses	34	23	35	..
Distance across postzygapophyses above	67	*50*	57	..
Transverse diameter of pedicel	26	15	20	20
Antero-posterior diameter of pedicel	42	40	49	49
Height of spine from neural canal to extremity	*162*	..	173	..
Antero-posterior diameter of spine above neural canal	50	40	52	..
Antero-posterior diameter of spine at top	*39*	..	47	..
Height of metapophysis above prezygapophysial face	*12*	5	3	..
Height of metapophysis above transverse process	*70*	51	57	..
Antero-posterior diameter of metapophysis below	*32*	25	35	..
Antero-posterior diameter of metapophysis (mammillary) at end	*22*	18	25	..
Distance across ends of metapophyses	*115*	82	105	..

The Sacral Vertebræ.

(Plates LIII–LX.)

Six specimens representing the sacral vertebræ have been made the subject of critical investigation. No. 1704 (Plates LIII–LVI) is a sacrum in which the centra and lateral processes are well preserved, but from which the extremities of the neural spines have been broken away, with the exception of the third, the greater portion of which remains. It is evidently the sacrum of an adult in which the vertebræ are thoroughly coössified. No. 1706 is the sacrum employed in the restoration of the mounted skeleton, and which is figured in Plates LVII–LX. It is in the main well preserved and has called for only a little repairing. It was found about twelve feet from the remains of the specimen catalogued as No. 1604 and may well have belonged to that individual. Specimen No. 1713 is the first sacral vertebra of a large but immature individual, the spine of which shows that coössification has not as yet taken place at its extremity, and the posterior epiphysis of the centrum has been lost. It is practically a perfect specimen with the exceptions just noted. No. 1714 is a specimen of the first sacral of quite small size

and evidently immature, having lost both the anterior and posterior epiphyses of the centrum as well as the greater part of the neural spine. It has been referred, because of the greater backward inclination of the spine, to *M. petersoni*. No. 1730 is a first sacral, likewise referred to *M. petersoni*. It has also lost the epiphyses of the centrum, the upper part of the neural arch, and the whole of the neural spine. Specimen No. 2102 consists of the first sacral, lacking the greater part of the neural spine, and the centrum of the second sacral thoroughly coössified with the centrum of the preceding vertebra. It shows some evidence of being water-worn.

The sacrum is composed of four vertebræ. In adult specimens the vertebræ are well coössified. The spines slope strongly backward and rapidly increase in transverse diameter at their extremities to the posterior margin of the third vertebra, and then rapidly diminish to a knife-edge at the posterior margin of the fourth vertebra. There is considerable diversity in the antero-posterior diameter of the neural spine of the first vertebra. The diameter is greater in *M. elatus* than in *M. petersoni*. In the latter species the backward inclination of the spines is greater than in *M. elatus*. In specimen No. 1706 (the mounted specimen) associated with the bones listed under No. 1604, the vertebræ are thoroughly coössified at their centra and above at their extremities. Between the posterior margin of the spine of the first vertebra and the anterior margin of the spine of the second vertebra there is in this specimen a lacuna about the middle, where the spines have failed to coössify. In specimen No. 1704 the spine of the first sacral has failed to coössify at its base with that of the succeeding vertebra, and there is in consequence an opening revealing the upper part of the neural arch of the second sacral behind the spine of the first sacral. The centra are greatly compressed vertically, and rapidly diminish backward both in vertical and transverse diameter. The neural canal likewise rapidly diminishes in the sacrum from before backward and is not so nearly circular in outline as in the dorsals and lumbars, but becomes more or less subtriangular, the transverse diameter being relatively considerably greater than the vertical diameter. The transverse processes or alæ which look outwardly and backwardly at their ends flare widely in order to form attachments with the ilium, with which in thoroughly adult specimens they are more or less firmly united. This lateral enlargement is greatest in the case of the first and second vertebræ, the transverse processes of which furnish the largest surface for adhesion to the ilium. There are three well developed ventral and dorsal foramina on either side, of which the anterior is much the largest, the ventral, viewed from below, being antero-posteriorly elongated and oval. The opening of the second

dorsal foramen is smaller than the other two; the second ventral foramen is intermediate in size between the first and the third. The metapophyses of the first sacral are well developed and are conformed in shape and size to those of the preceding lumbars. In the second and third sacral vertebræ the metapophyses appear as small elevations, that of the second vertebra being larger than that of the third, which is reduced to a mere tubercle.

The three sacra found in a coössified condition have been attentively studied and their measurements so far as their somewhat defective condition allows are here given.

Measurements of Sacrum.[46]

	1704, mm.	1706, mm.	2102, mm.
Greatest transverse diameter in front across ends of alæ	224	218	218
Greatest transverse diameter behind across ends of alæ	147	137	...
Greatest height from base to end of spines	*195*	210	...
Greatest length along median line of centra below	*190*	185	...
Length of neural canal measured along top of centra	180	177	...
Length of neural canal along neural arch	140	147	...
Vertical diameter of neural canal in front	26	19	23
Vertical diameter of neural canal behind	12	16	..
Transverse diameter of neural canal in front	42	47	50
Transverse diameter of neural canal behind	21	19	..
Vertical height of spines above neural arch	*150*	130	...
Greatest antero-posterior diameter of mass of laterally coössified alæ	177	200	...
Greatest vertical diameter of alæ of first sacral in front	120	95	100
Vertical diameter of anterior face of first sacral	50	44	50
Transverse diameter of anterior face of first sacral	100	103	105
Vertical diameter of posterior face of fourth sacral	*12*	*18*	..
Transverse diameter of posterior face of fourth sacral	*27*	*40*	..
Antero-posterior diameter of first ventral foramen	38	40	35
Transverse diameter of first ventral foramen	18	20	13
Antero-posterior diameter of second ventral foramen	16	10	..
Transverse diameter of second ventral foramen	20	10	16
Antero-posterior diameter of third ventral foramen	16	11	..
Transverse diameter of third ventral foramen	13	7	..
Antero-posterior diameter of first dorsal foramen	17	16	17
Transverse diameter of first dorsal foramen	13	14	10
Antero-posterior diameter of second dorsal foramen	9	13	..
Transverse diameter of second dorsal foramen	13	11	..
Antero-posterior diameter of third dorsal foramen	12	8	..
Transverse diameter of third dorsal foramen	20	14	..

[46] Figures italicized indicate approximate measurements, the specimens being broken or restored.

The First Sacral Vertebra.

(Plate LIV.)

The first sacral, in a disarticulated condition, is represented by three specimens, and the three sacra in which it is found in a coössified state also yield information as to its form. The accompanying table of measurements of the different specimens shows that there is considerable individual variation.

Measurements of First Sacral Vertebra.[47]

	1704, mm.	1706, mm.	1713, mm.	1714, mm.	1730, mm.	2102, mm.
Greatest vertical height of neural spine	...	210	230	...	...	...
Greatest transverse diameter across alæ	224	218	*210*	*170*	186	218
Greatest antero-posterior diameter across zygapophyses	115	120	115	85	..	*110*
Vertical diameter of anterior face of centrum	50	44	53	*30*	36	50
Transverse diameter of anterior face of centrum	100	103	*103*	*80*	83	105
Vertical diameter of posterior face of centrum	33	*24*	47	*22*	*27*	35
Transverse diameter of posterior face of centrum	52	50	72	*40*	*43*	65
Length of centrum along neural canal	60	70	55	*35*	*40*	62
Length of centrum along inferior surface	65	75	*59*	*40*	*45*	70
Vertical diameter of neural canal	26	19	20	15	*17*	23
Transverse diameter of neural canal	42	47	39	40	37	50
Vertical diameter of prezygapophysial surfaces	32	40	40	28	31	38
Antero-posterior diameter of prezygapophysial surfaces	39	33	27	20	24	32
Height of mammillary process above prezygapophysial surface	10	8	18	8	..	..
Height of metapophysis above transverse process or ala	32	16	55	22	*27*	..
Antero-posterior diameter of metapophysis at origin	32	40	32	27	25	40
Antero-posterior diameter of mammillary process	21	24	21	16	..	..
Antero-posterior diameter of postzygapophysial surfaces	..	..	45	..	..	..
Transverse diameter of postzygapophysial surfaces	..	..	28	..	..	..
Distance between posterior ends of postzygapophyses and posterior face of centrum	*30*	..	45	*30*	..	..
Antero-posterior diameter of spine above neural canal	44	49	57	29	..	47
Antero-posterior diameter of spine at extremity	..	38	44	..	..	..
Length of spine above neural canal	..	143	167	...	...	...

The Second Sacral Vertebra.

We have no knowledge of this element in the sacrum except as it is derived from the three sacra in which it exists as one of their coössified components. The neural spine in all of the specimens which have been recovered is apparently intermediate in its antero-posterior diameter between that of the first and the third

[47] Figures in italics denote approximate measurements, absolute certainty being impossible owing to defects.

sacral vertebræ, and its anterior margin is not so thoroughly coössified with the spine of the first vertebra as its posterior margin is coössified with the anterior margin of the third vertebra. Its centrum is smaller than that of the first sacral vertebra in all of its dimensions.

The Third Sacral Vertebra.

This vertebra is, like its predecessor, only known thus far in the coössified state in which it appears in specimens No. 1704 and No. 1706. While its centrum in its dimensions is less than those of the two preceding sacral vertebræ, the neural spine is longer and more massive in all dimensions than is the case in these, and marks the climax in development of this portion of the sacrum. It is strongly coössified on its anterior and posterior margins with the neural spines of the second and fourth sacral vertebræ.

The Fourth Sacral Vertebra.

The centrum is smaller in all of its dimensions than those of the three preceding sacral vertebræ. The neural spine is only known from specimen No. 1706. It is appressed against and coössified with the posterior margin of the spine of the third sacral vertebra. The antero-posterior diameter of the spine is less than that of the third sacral vertebra.

The Caudal Vertebræ.

Until the present time no caudal vertebræ, which can with positive certainty be identified as belonging to the various specimens of *Moropus* obtained at the Agate Spring Quarries, have been found. The ungulate mammals occurring in the quarry belonged to the genera *Diceratherium, Dinohyus, Stenomylus,* and

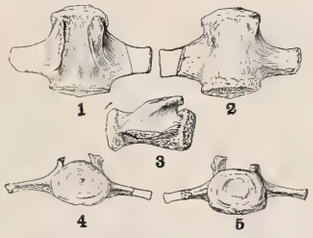


Fig. 73. Caudal vertebra of *M. elatus* (No. 2144). ×⅓. 1, dorsal, 2, ventral, 3, lateral, 4, anterior, 5, posterior, views.

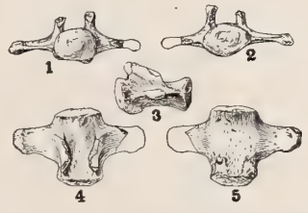


Fig. 74. Caudal vertebra of *M. elatus* (No. 1823). ×⅓. 1, posterior, 2, anterior, 3, lateral, 4, superior, 5, inferior, views.

Moropus. Fortunately some specimens belonging to the first-named genus were found with their caudal vertebræ articulated and in place, so that the identification of the caudals of this genus has been removed beyond the sphere of doubt. The

caudals belonging to *Dinohyus* are also of a well-known type and can be positively identified when found; this is also true of *Stenomylus*, perfectly articulated and complete skeletons of which in considerable number were recovered near by in the summer of 1908. After the caudals which apparently ought to be referred to these genera have been eliminated, there remain but two specimens representing caudal vertebræ which, because they apparently belong to none of the genera mentioned, might with plausibility be referred to the genus *Moropus*. The accompanying figures (Figs. 73 and 74) give the outlines of these bones. The existence of the neural arch though evidently open shows that they must have occupied a position well forward in the caudal series. They were possibly the sixth or seventh in the series, reckoning backward. In form they somewhat resemble the caudals of *Dinoceras*, though the flattened lateral processes do not have as great an antero-posterior diameter as in *Dinoceras*. They must have appertained to small individuals. As has been remarked on p. 250 the tail which has been given to the restored skeleton is "a work of fiction," based in part upon these two bones and the analogies of the caudal region in other perissodactyla.

The Pelvic Girdle.

(Plates LVIII–LXI.)

The pelvis of *Moropus* is represented, in addition to the more or less perfect remains of the sacra of several individuals which have already been described, by the following material:

Catalog No. 1706 (Moropus elatus).

A complete pelvis including sacrum which has been utilized in the mounted specimen.

Catalog No. 1701 (Moropus petersoni).

The left os innominatum of a specimen which has been used in effecting the restoration of the hind foot and limb of *Moropus petersoni*. With this the writer associates specimen No. 1795, which is a right innominate bone. The two bones, the one in the restored hind limb and specimen No. 1795, apparently fit each other, and when placed together they show that the pelvic aperture is much smaller than is the case in specimen No. 1705. This caused the writer to believe that we have therefore corresponding portions of the pelvic arch of both a male and female individual of the same species.

Catalog No. 1705 (Moropus petersoni).

This specimen consists of the two ossa innominata of an apparently mature individual, which, owing to the size of the pelvic aperture, the writer is inclined to regard as having belonged to a female, as he has stated previously (*vide* description of *M. petersoni*).

Catalog No. 1793 (Moropus elatus).

This consists of the right os innominatum of a large individual presumably representing *Moropus elatus*.

Catalog No. 1793A.

This specimen consists of portions of the left innominate bone of a specimen of *Moropus elatus* somewhat smaller in size than No. 1793.

Catalog No. 1794 (Moropus elatus).

This consists of a fragment of the innominate bone, preserving the acetabulum, thyroid foramen, and the portions of the ilium, ischium, and pubis surrounding the acetabulum and the thyroid foramen. It represents an adult specimen of *Moropus elatus*.

Catalog No. 1795 (Moropus petersoni).

This bone has been already referred to and commented upon in the paragraph dealing with specimen No. 1701, to which it apparently belongs.

In addition to this material there are a number of fragments which the writer does not deem it necessary to more than refer to.

In all the material before the writer the ilium, ischium, and pubis are firmly coössified with each other, but not with the sacrum, which nevertheless in the case of specimen No. 1706 was found *in situ* lying between the ilia in such a manner as to show that when fully adult a firm union between the sacrum and the ilia was undoubtedly effected. It is evident that the union of the three bones which enter into the composition of the innominate bone took place, as in other mammalia, at a very early period, probably even during the fœtal life of the animal. Few specimens have been found in which the sutures between the ilium, the ischium, and the pubis are visible.

The *ilia* are broadly expanded anteriorly, subtriangular in outline, the supra-iliac border rising high above the line of union with the sacrum, flaring upward and outward at the anterior extremity, thus giving this portion a somewhat scroll-shaped form, causing the gluteal surface to be deeply concave in front. The bone between the broad expanded anterior portion and the acetabulum is lengthened

and triangular in cross-section behind the posterior spine which is not high. The ilium expands somewhat posteriorly to form the anterior walls of the acetabulum.

The *os pubis* is relatively small. In cross-section immediately in advance of the anterior extremity of the thyroid foramen it is subtriangular, the base of the triangle being represented by the anterior free surface. From this point the bone expands broadly inwardly, becoming somewhat pyramidal in form, the base of the pyramid being located at the symphysis and continued backward as the ramus forming in part the inner boundary of the thyroid foramen to the point where coössification with the ramus of the ischium takes place. The os pubis expands externally and enters into the composition of the acetabulum to the extent of about one-fifth, including the lower half of the cotyloid notch, as is shown in the case of the left innominate bone of specimen No. 1705, in which the sutures in the acetabulum are visible. The acetabulum is large and deep. The pit for the round ligament is large and located in the posterior portion of the cavity.

The *ischium* is intermediate in size between the smaller pubis and the vastly larger ilium. In *M. petersoni* the bone is relatively shorter than in *M. elatus* and is not strongly everted at its extremity as in the latter species. In the portion of the bone found, the external lateral margin of the thyroid foramen is triangular in cross-section, passing insensibly into the broad plate which forms the posterior portion of the bone, which is thickest laterally and terminates in the strong, roughened tuberosity. The inner margin of the bone is thin on its edge and produced forward in the ramus, which coössifies with the ramus of the pubis to form the inner margin of the thyroid foramen. The anterior part of the ischium enters into the composition of the acetabulum for about one-fourth of its surface.

The *thyroid foramen* is elongated, oval, with the longer axis parallel to the line of the symphysis.

The pelvis when compared with that of other Perissodactyls is seen to be relatively longer and narrower than is usually the case in this suborder, and especially when compared with the Titanotheres of the Oligocene. This elongation is chiefly brought about by the extension behind the acetabulum of the ischium and pubis to which Peterson called attention (*l. c.*, p. 748). The gluteal surface of the ilium, when compared with the same surface in other genera, is relatively small. It is more everted than in *Titanotherium*, and more closely resembles the corresponding part in such forms as *Cœnopus tridactylus*, *Trigonias osborni*, and the modern horse, except that the supra-iliac border is filled out more roundly than in the latter genera. The supra-iliac border rises high above the pleurapophyses of the sacrum, very much as in *Trigonias*, *Diceratherium*, and other Perissodactyla.

The shaft of the ilium is rather long, when compared with that of the Titanotheres, and is more like that of the Miocene rhinoceroses.

Measurements of Pelvis.[48]

	No. 1706 (*elatus*), mm.	No. 1701 (*petersoni*), mm.	No. 1705 (*petersoni*), mm.
Total length from point of ilium to end of ischial tuberosity	755	450	468
Distance from point of ilium to margin of acetabulum	390	255	285
Distance from acetabulum to end of ischial tuberosity	265	120	142
Transverse diameter between points of ilia	638	*326*	458
Transverse diameter at the acetabula	386	*220*	248
Extreme width between ischial tuberosities	324	*168*	141
Length of obturator foramen	*103*	80	80
Antero-posterior diameter of acetabulum	93	73	72

The Ribs.

(Plates LXII–LXIV.)

The material representing the ribs secured for the Carnegie Museum during the excavations made from 1905 to 1907 consists of the ribs belonging to the mounted specimen, No. 1604, all of which were found, except the first rib on the left hand side, which in the mounted specimen has been reproduced from the corresponding rib on the right hand side, which was found in practically perfect condition. These bones belonged to *Moropus elatus*. In addition to this material, ribs representing other specimens of *Moropus elatus*, and also belonging undoubtedly to *Moropus petersoni* were found in Quarry No. 2. This material is cataloged as follows:

Catalog No. 1760 (M. petersoni).

Left first rib; left thirteenth rib; right eleventh rib.

Catalog No. 1760A (M. petersoni).

Right first rib.

Catalog No. 1761 (M. petersoni).

Two anterior ribs.

Catalog No. 1762 (M. petersoni).

A series consisting of twenty-two ribs, many of them in excellent condition.

Catalog No. 1763 (M. elatus).

A series consisting of nineteen ribs in more or less perfect condition, together with the manubrium of the sternum in perfect condition.

[48] Measurements in italics are approximate.

In addition to the material above enumerated there are more or less fragmentary portions of the ribs of other individuals collected in the summer of 1908, which have not as yet been removed from the matrix, and upon which no report can at present be made.

Moropus possessed fifteen ribs on each side, of which the first is the shortest. The ribs gradually increase in length from the first to the eighth, which is the longest, and gradually decrease in length from the eighth to the fifteenth. The first three anterior ribs have a less convex external curvature than the others, but the curvature rapidly increases posteriorly and reaches its maximum development in the four posterior ribs, the curvature in which is very nearly the same. All of the ribs except the fifteenth show at their end provision for the attachment of cartilages. The fifteenth rib was free. The capitulum the faces of which always coalesce is carried in the case of the anterior rib upon a long neck; the length of the neck decreases as we go backward along the series to the third, and then increases to the sixth, after which it gradually diminishes until we reach the thirteenth rib, where the capitulum and tuberculum fuse with each other. The fourteenth and the fifteenth ribs retain only vestiges of the angle in the form of a slight swelling below the fused capitulum and tuberculum.

In comparing the ribs of *Moropus elatus* and *Moropus petersoni* we discover, as might be expected, that the ribs of the latter are not as massive or as heavy throughout, the animal being smaller.

The First Rib.

The first rib is short, flattened, broadest at its extremity; the capitulum is supported upon a relatively long neck, strongly constricted before the tuberculum, the axis of which forms approximately a right angle with the axis of the shaft.

Measurements (No. 1604).

	Mm.
Length of first right rib. Measured in a straight line from top of capitulum to outer angle of shaft	276
Diameter of upper portion including head	*81*
Greatest diameter of shaft near the middle	42
Greatest diameter of shaft near end, estimated	*66*

The Second Rib.

The second rib is a little more than one-third longer than the first rib. It is flattened in its lower two-thirds, somewhat wider just beyond the middle than at the end. The neck supporting the head is only about half as long as the corresponding portion of the first rib.

Measurements (No. 1604).

	Mm.
Length of second right rib. Measured in a straight line	444
Diameter of upper portion including head	68
Greatest diameter of shaft near the middle, estimated	45
Greatest diameter of shaft near end, estimated	45

The Third Rib.

The third rib is nearly twice as long as the first rib; the neck supporting the head is reduced in length; the shaft is convex externally. Distally for two-thirds of its length it is flat or very slightly concave internally. Below the tuberculum on the internal side is a deep groove tapering at its distal extremity and terminating about one-third of the length of the rib near the posterior margin.

Measurements (No. 1604).

	Mm.
Length of third right rib. Measured in a straight line	546
Diameter of upper portion including head	66
Greatest diameter of shaft near the middle	40
Greatest diameter of shaft near end, estimated	51

The Fourth Rib.

The neck supporting the capitulum is slightly longer in this rib than in the third rib. The shaft externally is convex; internally it is flattened and about the middle slightly excavated. Below the tuberculum the transverse diameter of the rib increases and its antero-posterior diameter diminishes. On both the anterior and posterior surfaces below the capitulum there is a deep groove, which gradually diminishes until it disappears about one-third of the distance from the head of the rib.

Measurements (No. 1604).

	Mm.
Length of fourth right rib. Measured in a straight line	580
Diameter of upper portion including head	71
Greatest diameter of shaft near the middle	40
Greatest diameter of shaft near end, estimated	47

The Fifth Rib.

The fifth rib is somewhat longer than the fourth. The transverse diameter of that portion of the rib immediately below the tuberculum is greatly increased and a well defined angle is developed beyond the tuberculum. The anterior and posterior grooves beyond the tuberculum are as long as in the preceding rib, but somewhat shallower. The rib on its external surface is convex; on its internal

surface at its extremity and below the head slightly convex, but about the middle flat, or slightly concave. At its distal extremity the rib curves backward.

Measurements (No. 1604).

	Mm.
Length of fifth right rib. Measured in a straight line	622
Diameter of upper portion including head	85
Greatest diameter of shaft near the middle	39
Greatest diameter of shaft near end	49

The Sixth Rib.

The sixth rib in its general outlines is similar to the fifth rib; the neck supporting the capitulum is, however, somewhat longer and the angle beyond the tuberculum somewhat more pronounced. The rib is longer than its predecessor, and is the most massive rib of the series.

Measurements (No. 1604).

	Mm.
Length of sixth right rib. Measured in a straight line	648
Diameter of upper portion including head	86
Greatest diameter of shaft near the middle	39
Greatest diameter of shaft near end	62

The Seventh Rib.

The seventh rib only slightly exceeds the sixth rib in length; it corresponds with it in form, the neck supporting the capitulum is, however, considerably shorter and the angle appears at a point somewhat further removed distally from the capitulum than in its predecessor. The antero-posterior diameter of the rib at its extremity is less than that of the sixth rib.

Measurements (No. 1604).

	Mm.
Length of seventh right rib. Measured in a straight line	656
Diameter of upper portion including head	93
Greatest diameter of shaft near the middle	43
Greatest diameter of shaft near end	61

The Eighth Rib.

The eighth rib is the longest rib of the series; its antero-posterior diameter at its extremity is considerably less than that of the ribs preceding it; the angle is further advanced distally than in its predecessor. The neck supporting the capitulum is of about the same length as in the seventh rib.

MEASUREMENTS (No. 1604).

	Mm.
Length of eighth right rib. Measured in a straight line	664
Diameter of upper portion including head	66
Greatest diameter of shaft near the middle	35
Greatest diameter of shaft near end	44

The Ninth Rib.

The ninth rib is shorter than its predecessor; the bone is very much reduced in all its diameters from those that precede it and shows a tendency throughout to become more oval in cross-section. The angle on this rib is further removed distally from the capitulum than in any of the ribs preceding or succeeding it and is followed by a flattened depressed surface externally.

MEASUREMENTS (No. 1604).

	Mm.
Length of ninth right rib. Measured in a straight line	634
Diameter of upper portion including head	67
Greatest diameter of shaft near the middle	29
Greatest diameter of shaft near end	37

The Tenth Rib.

The tenth rib is considerably shorter than its predecessor. Its antero-posterior diameter is less than in any of the ribs preceding it. The angle retreats toward the capitulum and is followed distally by a flattened excavated surface. In cross-section throughout the greater part of its length the bone is approximately oval.

MEASUREMENTS (No. 1604).

	Mm.
Length of tenth right rib. Measured in a straight line	605
Diameter of upper portion including head	60
Greatest diameter of shaft near the middle	25
Greatest diameter of shaft near end	32

The Eleventh Rib.

The eleventh rib is shorter than the tenth, somewhat lighter; a deep groove runs along its posterior face from the capitulum to beyond its middle. Its anterior surface is strongly convex. The angle is situated at about the same distance from the capitulum as in its predecessor, and, like it, followed distally by a flattened somewhat excavated surface. The rib in cross-section is very irregular at different points, but toward its extremity shows a tendency to become rotund.

Measurements (No. 1604).

	Mm.
Length of eleventh right rib. Measured in a straight line	572
Diameter of upper portion including head, estimated	53
Greatest diameter of shaft near the middle	25
Greatest diameter of shaft near end	29

The Twelfth Rib.

The twelfth rib closely resembles the eleventh rib in outline, but is shorter and slenderer. The capitulum and tuberculum approach each other closely, the neck bearing the capitulum being relatively quite short.

Measurements (No. 1604).

	Mm.
Length of twelfth right rib. Measured in a straight line	556
Diameter of upper portion including head	51
Greatest diameter of shaft near the middle	23
Greatest diameter of shaft near end	27

The Thirteenth Rib.

The thirteenth rib is characterized by a fusion of the capitulum with the tuberculum in one mass. The capitular surface looks inward toward the centra, the tubercular surface looks slightly inward and strongly backward. The rib is much shorter than its predecessor. The angle retreats toward the capitulum, and is followed distally, as in the preceding ribs, by a flattened external surface.

Measurements (No. 1604).

	Mm.
Length of thirteenth right rib. Measured in a straight line	510
Diameter of upper portion including head	49
Greatest diameter of shaft near the middle	25
Greatest diameter of shaft near end	28

The Fourteenth Rib.

The fourteenth rib is short, approximately rotund in cross-section throughout the shaft until the external third is reached, when it becomes somewhat oval. The angle appears as a slight roughened tuberosity situated beyond the tubercular articulating face, which looks backward, while the capitular surface looks forward. The flattened external surface which occurs just beyond the angle, and is a marked feature in the ribs from the ninth to the thirteenth, does not make its appearance in this rib.

Measurements (No. 1604).

	Mm.
Length of fourteenth right rib. Measured in a straight line	460
Diameter of head	27
Greatest diameter of shaft near the middle	22
Greatest diameter of shaft near end	25

The Fifteenth Rib.

The fifteenth rib is quite short and reduced to a fine point at its extremity. In transverse section it is somewhat oblong from the middle to the end. At its upper extremity it is subtriangular in section below the angle, which is indicated merely as a slight tuberosity succeeding the tubercular face. The capitulum and tuberculum in this rib are united, the capitular surface looking forward and inward in relation to the vertebræ, and the tubercular surface looking inward and backward.

Measurements *M. elatus* (No. 1604).

	Mm.
Length of fifteenth rib. Measured in a straight line	330
Diameter of head	27
Greatest diameter of shaft near the middle	24
Greatest diameter of shaft near the end	13

The Sternum.

But few remains of the sternum have been found in our quarries. The only portion of this element thus far detected in the material which has been excavated and freed from the matrix is a manubrium (No. 1763) pertaining to an apparently adult specimen of *Moropus elatus* (?) somewhat smaller in size than No. 1604. This manubrium has been used as the model in preparing the sternum utilized in the mounted skeleton. The accompanying illustration (Fig. 75) gives the outline of this specimen.

The manubrium is laterally compressed as in other perissodactyls, its height being greater than its width. This compression is most noticeable on the under side, the lower portion of the bone being thin and sharp. The anterior end extends well in front of the surfaces for the attachment of the ribs. Back of the attachment for the ribs the bone is triangular in cross-section, with the superior and lateral surfaces subequal in diameter, while inferiorly there is a sharp, but rounded border or keel. The posterior end is enlarged to accommodate the mesosternum, and the second pair of ribs.

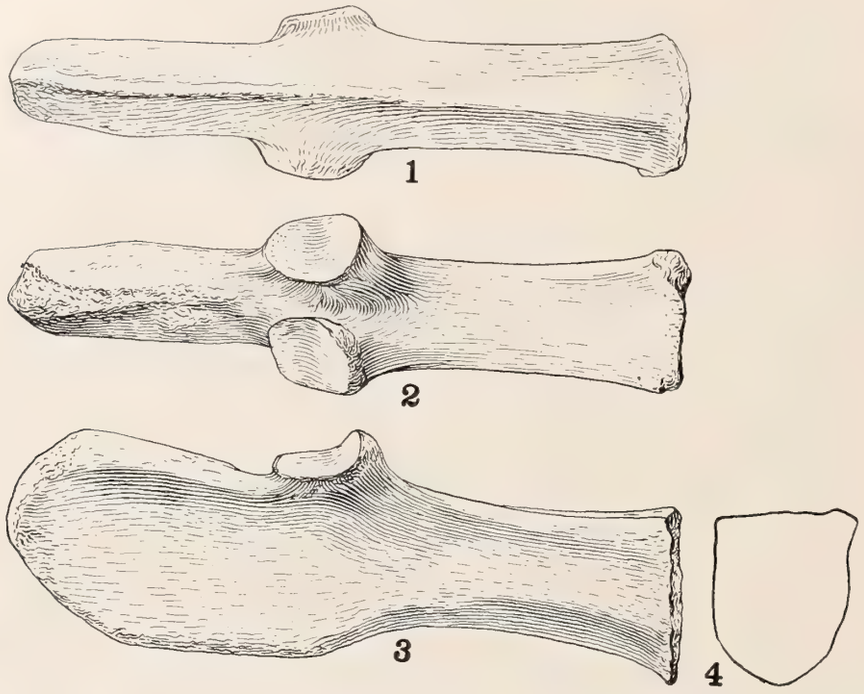


FIG. 75. The manubrium of *M. elatus* (?) (No. 1763). ×⅓. 1, inferior view; 2, superior view; 3, lateral view; 4, cross-section at posterior extremity.

MEASUREMENTS of MANUBRIUM *M. elatus* (?) (No. 1763).

	Mm.
Greatest length	210
Transverse diameter, anterior end	27
Transverse diameter, at attachment for ribs	54
Transverse diameter, at posterior end	45
Vertical diameter, near anterior end	65
Vertical diameter, back of attachments for ribs	37
Vertical diameter, at posterior end	52

THE FORE LIMB.

(Plates LXIV–LXVIII.)

The fore limbs, as was pointed out by Peterson in 1907,[49] compare best with those of the Perissodactyla. The scapula is relatively broad, and nearly as long as the humerus. The radius and ulna are coössified proximally and distally, and in old specimens of *Moropus* and *Nestoritherium pentelici* throughout their entire length. The feet are mesaxonic, the line through which the weight of the body passes being through the lunar, the magnum, and the third digit, of the manus, and through the third digit of the pes. The unguals are deeply bifid.

[49] Peterson, O. A., American Naturalist, Vol. XLI, p. 745 (1907).

The Scapula.

(Plate LXIV.)

In the material obtained by the Carnegie Museum there are a number of well-preserved scapulæ, and numerous fragments. Of the latter we shall take no account in the present paper. The scapulæ which have been cataloged, and which will be referred to in the succeeding paragraphs are the following:

No. 1604 (*M. elatus*).

This is a left scapula of large size, which was found associated with the other remains, which have been used in restoring the mounted skeleton. The right scapula in the restoration is artificial.

No. 1700 (*M. petersoni*).

This is a finely preserved left scapula employed in mounting the fore limb of *M. petersoni*, a drawing of which is herewith given (Fig. 76).

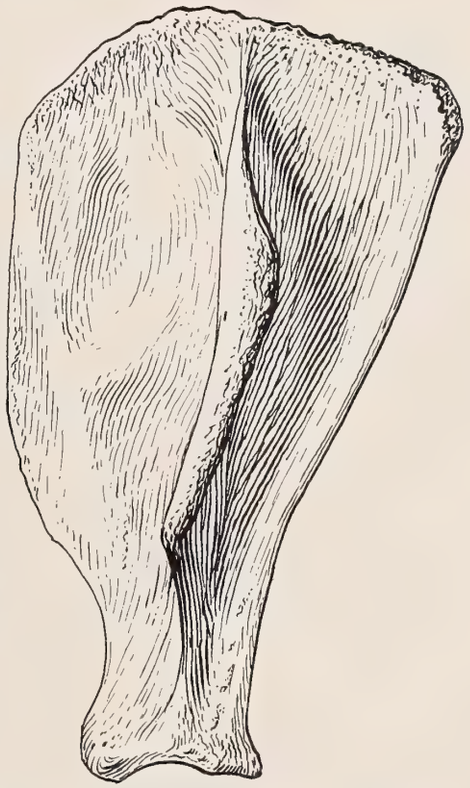


Fig. 76. Left scapula of *M. petersoni* (No. 1700). $\times\frac{1}{4}$.

No. 1706B (*M. elatus*).

A large left scapula, undoubtedly referable to *M. elatus*, found associated with a pelvis and hind limbs (No. 1706) and portions of the hind feet (No. 1706*A*).

No. 1712 (*M. petersoni*).

A left scapula of small size, referred provisionally to *M. petersoni*.

No. 1765.

A very small right scapula undoubtedly representing a very immature individual (species indeterminate).

No. 1770 (*M. elatus*).

A right scapula of a large individual of *M. elatus*. The specimen is slightly distorted through crushing.

No. 1771 (*M. elatus*).

A right scapula of large size from Quarry No. 2, collected by W. H. Utterback.

No. 1771a (*M. elatus*).

A left scapula of large size found near No. 1771, and closely resembling it in size and outline, so that it may well be regarded as having belonged to the same individual.

No. 1775.

Right and left scapulæ of small size, and apparently immature. Specific determination conjectural.

No. 1776 (*M. maximus*).

A very large left scapula from Quarry No. 2. Its peculiarities have already been referred to on p. 230, and it is represented in Figure 77.

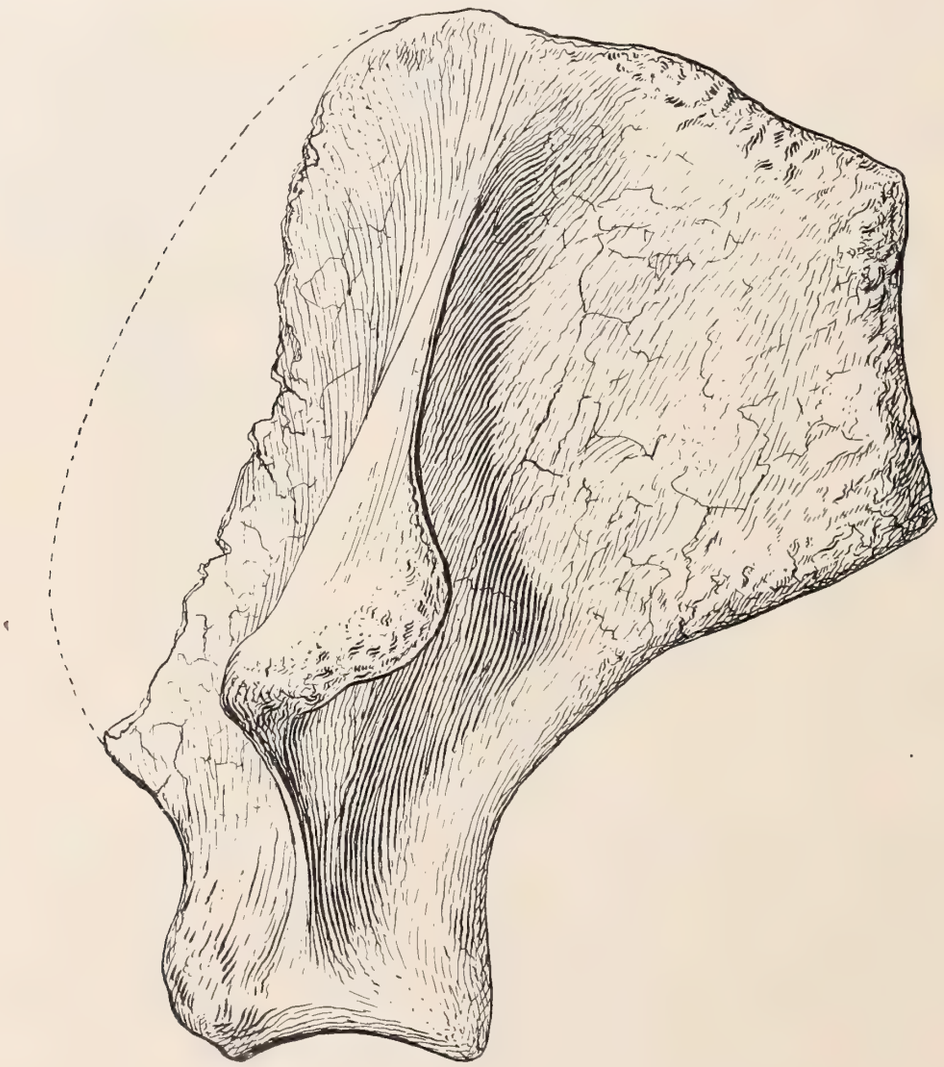


FIG. 77. Left scapula of *M. maximus* (No. 1776). ×¼.

In specimen No. 1604, used in effecting a restoration of the skeleton, the

scapula has reached complete development. The posterior border is gently concave from the glenoid cavity to a point nearly opposite the middle of the spine, where the border becomes thickened and rugose, rounding outwardly and upwardly to the suprascapular border. The latter is quite heavy and gently rounded from before backward. The anterior border has a thin sharp edge, running in nearly a straight line, parallel to the spine from the anterior upper angle for all of two-thirds of the length of the bone, and then curving inwardly, showing a deep emargination above the nodule of the coracoid. The prespinous portion of the blade agrees in its form and relative extent with what is found in such forms as *Cœnopus* and *Titanotherium*. The posterior border of the scapula resembles more nearly that of *Cœnopus tridactylus* than of *Titanotherium*, terminating usually in an evenly rounded posterior angle, as in the former, and not in a prominent, heavy, and rugose angle, as in the latter. However, in *M. maximus* the outline of the posterior border tends somewhat to recall the form which is characteristic of the titanotheres. The glenoid cavity is quite large, subcircular in outline, but not very deep. The spine, especially in old individuals, is as prominent as in *Titanotherium*, and its crest is reflexed and has nearly as heavy and rugose a surface for muscular attachments as in the latter genus. The inner aspect of the scapula presents a broad and gently concave surface, which in old specimens is broken by ridges for tendinous insertions.

The foregoing description applies to the scapula of *M. elatus*, but in the case of the corresponding bone in *M. petersoni* we observe that the width in proportion to the height is less, and that the rugose surface of the crest of the spine is narrower, and not so greatly extended backward. In the scapula of *M. maximus* the backward extension of the crest of the spine is not located at the middle of the crest as in *M. elatus* and *M. petersoni*, but at its lower extremity (see Fig. 77), thus giving the bone quite a different facies from that presented by the same element in the other two species.

Measurements of Scapula.

	No. 1604 (*elatus*), mm.	No. 1700 (*petersoni*), mm.	No. 1776 (*maximus*), mm.	No. 1765 (*sp. indet.*), mm.
Height	528	423	593	323
Greatest width	327	240	*460*[50]	175
Width of neck	109	80	170	60
Antero-posterior diameter of glenoid cavity	104	75	137	72
Transverse diameter of glenoid cavity	103	80	...[51]	62
Vertical diameter of coracoid process	49	35	62	35
Greatest height of spine above blade	93	80	133	55
Greatest width of thickened edge of spine	57	32	88	15

[50] Conjectural.

[51] Badly crushed.

The Humerus.

(Plate LXVI.)

The humerus, when compared with that of *Titanotherium*, is long and slender. The head is quite large and the articulating surface is evenly rounded. The tuberosities, though robust, are not more strongly developed than in other Oligocene and Miocene Perissodactyla, but project above the articular surface very much as in the latter. The bicipital groove, as stated by Peterson (*l. c.*, p. 745), is single, quite broad, but shallow when compared with that of other Perissodactyla. The deltoid ridge is prominent, extends well down on the shaft, and is flexed backward over the external face of the shaft. The shaft below the deltoid ridge is trihedral in cross-section, due to the continuation on the anterior face of the shaft of a prominent ridge from the deltoid downward to the supratrochlear fossa (see Plate LXVI) as well as to the heavily developed posterior internal angle of the shaft, and the development of the ectocondylar ridge.

The distal end of the humerus is quite unlike that of the Perissodactyla generally, and recalls some of the features which occur in the *Ursidæ* among the carnivores. This end of the bone has a primitive appearance, and has already been compared by Peterson with *Phenacodus* from the early Tertiary (*l. c.*, p. 746). The distal extremity is much expanded transversely, the trochlea is very broad, with well-rounded articulating surfaces for the radius, and the intercondylar ridge is represented by a large, evenly convex area for the ulna, close to the deepest portion of the trochlea, an arrangement unlike the more or less decided ridge which is generally found at this point in the Perissodactyla. The ectocondylar ridge is prominent, but not so much so as in other persissodactyls, *e. g.*, the *Titanotheriidæ*, while the strong development of the entepicondyle is entirely unlike what is found in the true Perissodactyla, and strikingly suggests what is seen in *Ursus*. The animal was evidently provided with an unusual development of the pronator teres and the different flexor ligaments of this region. The anconeal fossa is deep and broad, while the supratrochlear fossa is rather small and shallow.

In *Nestoritherium pentelici* the proximal end of the humerus, as represented by a cast of the specimen preserved in Paris, is injured. The articulating surface of the head is, however, preserved, and is apparently identical in its general features with that of *Moropus*. The deltoid crest appears to decrease more gradually in its downward course, and the anterior face of the shaft presents a heavier and more rounded ridge running from the deltoid to the supratrochlear cavity than in the American genus. The ectepicondyle is more, and the entepicondyle less, developed

than in *Moropus*, and the transverse diameter of the trochlea is relatively smaller, due to the narrower capitellum for the articulation with the radius. The anconeal fossa is similar in every respect in the two genera, which we are comparing; but the supratrochlear fossa is apparently less distinct in the animal from Pikermi. The humerus as a whole is relatively shorter and heavier in *Nestoritherium* than in the American genus.

In *Macrotherium*, as shown by the illustrations given by Blainville, the humerus differs from that of *Moropus* and *Nestoritherium* by having the deltoid ridge less extended downwardly, by the apparently smaller internal condyle, and by the greater development of the lower radial portion of the shaft and the region of the entepicondyle.

Measurements of the Humerus.

	No. 1604 (*elatus*), mm.	No. 1700 (*petersoni*), mm.
Greatest length	635	464
Transverse diameter at head	200	150
Antero-posterior diameter at head	160	110
Greatest transverse diameter at distal end	210	142
Transverse diameter at trochlea	144	104
Antero-posterior diameter at distal end	108	85

Radius and Ulna.

(Plate LXVII.)

There are a number of individuals, possibly eight or ten, represented by the radius and ulna in the Carnegie Museum.

The radius and ulna are long and slender. In fully adult individuals these two bones generally coalesce at least proximally and distally. In *M. elatus* (No. 1604) the ulna and radius are coössified throughout, except for a large oblong opening between the two shafts a short distance below the head of the radius.

The Radius.—The head of the radius is very broad transversely in order to conform to the broad trochlea of the humerus. Proximally there are two large facets for the humerus, which are divided by a prominent ridge. The facet on the ulnar side of the ridge is the larger of the two, and forms a shallow basin, while the facet on the radial side is more nearly plane. Posteriorly there is a broad attachment for the ulna, while anteriorly and on the sides the head of the radius is rather smooth. The shaft is twisted upon its own axis and is not much widened transversely, as is generally the case in the early ungulates, rather suggesting the primitive condition found in the Oligocene oreodonts. In No. 1604 there is a prominent

rugosity on the lower half of the radial face of the shaft for muscular attachments. From this point downward to the distal end the dorso-radial angle of the shaft is developed into a strong ridge, which terminates in the greatly produced styloid process of the radius somewhat as in *Titanotherium*. Dorsally there is a broad, deep, well-defined groove for the extensor tendons. Peterson (*l. c.*, p. 746) says: "The distal end of the radius and ulna together have a transversely broad aspect, the carpal articulation is characteristically plain without the prominent border [ridge] which separates the scaphoid and lunar facets in other Perissodactyla." The articular surface for the cuneiform on the ulna projects only very slightly below the radius, and forms with the lunar articulation on the radius a continuous and gently curved surface. The suture between the radius and ulna is well indicated on the distal articulating surface of the bone.

The Ulna (Pl. LXVII).—The ulna is rather heavy, its olecranon process heavy and truncated, convex and very rugose externally, concave and smooth internally, and without a tendinal groove supero-anteriorly. The sigmoid notch is quite deep; the principal part of its lower portion located on the radial side and facing upward and forward, while on the ulnar side the coronoid process is rather small. Below the sigmoid cavity there is on the anterior face of the shaft a broad attachment for the corresponding surface on the head of the radius. The shaft is quite heavy, trihedral in cross-section and twisted to conform to the curvature of the shaft of the radius.

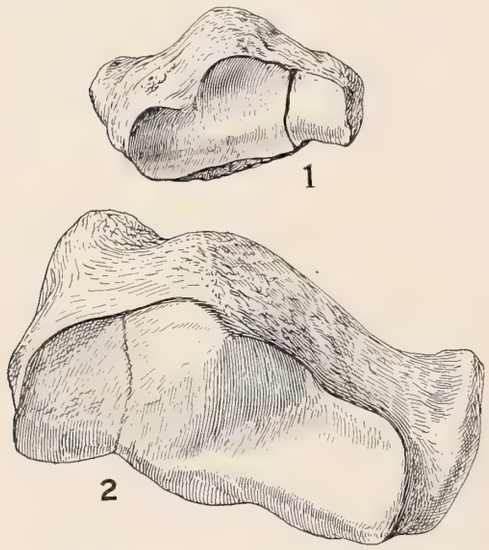


Fig. 78. 1. Distal articulating surface of left ulna-radius of *M. petersoni*. ×⅓. 2, do. of right ulna-radius of *Nestoritherium pentelici*. ×⅓.

The radius and ulna in *Nestoritherium pentelici* closely resemble the same bones in *Moropus*. In the remains from Greece the olecranon process is, however, more truncated; the upper part of the sigmoid notch less prominently developed; and the shaft proportionally heavier. In fact the forearm as well as the humerus are shorter and stouter in *Nestoritherium* than in *Moropus*.

If the radius of *Macrotherium* figured by Blainville belongs to the same individual as the humerus depicted by him, the lower arm in this genus must have been proportionally much longer than in either *Moropus* or *Nestoritherium*.

Measurements of Ulna-Radius.

	No. 1604 (*elatus*), mm.	No. 1700 (*petersoni*), mm.	No. 1782 (*petersoni*), mm.
Greatest length of ulna	709	575	540
Length of olecranon process	177	116	116
Transverse diameter of ulna at the upper margin of the sigmoid notch	45	38	35
Transverse diameter of ulna at middle of sigmoid notch	45	37	35
Transverse diameter of ulna at coronoid process	145	95	83
Antero-posterior diameter of ulna at upper margin of sigmoid notch	118	90	90
Antero-posterior diameter of ulna at middle of sigmoid notch	72	57	55
Antero-posterior diameter of ulna at coronoid process	70	65	60
Antero-posterior diameter of ulna at distal articular surface	45	...	27
Transverse diameter of ulna at distal end	40	...	27
Greatest length of radius	580	460	452
Antero-posterior diameter of head of radius	56	45	42
Transverse diameter of head of radius	140	110	102
Transverse diameter of head of radius and ulna united	148	110	105
Transverse diameter of distal articulating surface of radius and ulna united	184	102	91

The Fore Foot.

(Plates LXVIII–LXIX.)

The carpus is diplarthrous, low, and broad. The metacarpals are long, cylindrical, very robust, and have curiously shaped distal ends, especially adapted for the reception of the anomalous phalanges, and the sesamoids on the plantar surface. The phalanges are rather short and heavy. The terminal phalanges are cleft at their extremities, and in life were covered by high and narrow hoofs.

The Carpal Elements.

The bones of the carpus are represented in our collection by scores of specimens coming from a multitude of individuals. In the following descriptions we have mainly utilized the material represented in the articulated skeleton, though frequently employing other specimens for purposes of comparison.

The Scaphoid (Fig. 79).—The scaphoid is heavy and very broad. The general shape of this bone is strikingly similar to the scaphoid of the *Titanotheriidæ*. The proximal surface, or the articulation for the radius, is even more plane, but covers a relatively smaller area than in the latter family, the postero-ulnar portion of the bone continuing as a rough and uneven surface in *Moropus elatus*, while in *Titanotherium* the articulation covers nearly the entire proximal face. Anteriorly, radially, and posteriorly, the scaphoid of No. 1604 is symmetrically rounded in outline. The ulnar face has two facets for the lunar, near the anterior face,

one superior and the other inferior (see Fig. 79, 2). The former is plane and suboval in outline, while the latter is divided by a rounded ridge, which is nearly vertical in position. The portion anterior to this ridge is a basin-shaped surface suboval in outline, and the portion back of the ridge is plane and triangular in outline. These features vary somewhat in different individuals. Immediately anterior to these articulating surfaces the bone is deeply excavated forming a large and irregularly shaped cavity when the scaphoid and lunar are placed in position. This cavity is rapidly contracted posteriorly at the point between the upper and lower facets for the lunar, described above, and continues to the palmar face of the scaphoid. On the ulnar face, back of the superior lunar facet, there is a heavy and rough ridge, but no articular facet for the lunar. The facets for the trapezium, trapezoid, and magnum take up the distal face of the scaphoid in an unusually unequal manner, the facet for the trapezoid occupying by far the greater portion of the three. The facet for the trapezium is convex fore-and-aft as well as laterally and takes up the inferior face of a prominent tubercle, which is located on the postero-radial angle and descends to a considerable extent over the supero-lateral face of the trapezoid. The articular facet for the trapezoid is obliquely concave antero-posteriorly and somewhat saddle-shaped in its general form, due to the prominence of the arm, which, extending in the ulnar direction, articulates with the magnum; and also due to the low facet for the trapezium described above. The facet for the magnum is confined to the distal end and very slightly to the postero-ulnar angle of the heavy descending arm of the scaphoid (see Fig. 79, 1, 2 and 4). This arm of the scaphoid has been referred to by Mr. Peterson as a possible remnant of the *centrale*, which was characteristic of the early Tertiary mammals.[51]

FIG. 79. Scaphoid of *M. elatus* (No. 1604). $\times\frac{1}{3}$. 1, anterior view; 2, internal lateral view; 3, radial view; 4, posterior view; 5, inferior view; 6, superior view.

The greater portion of the fore foot and the lower portion of the radius and ulna of *Nestoritherium* are represented by plaster casts in the Carnegie Museum. The scaphoid as represented in these is unlike that of *Macrotherium* and *Moropus elatus*, in having a much smaller vertical diameter, and by the extremely small development of the descending arm on the ulnar angle. Furthermore the broad

[51] "Preliminary Notes on Some American Chalicotheres," American Naturalist, Vol. XLI, p. 747 (1907).

palmar process is more prominent, and the articulating facet for the trapezoid is decidedly basin-shaped, while in *Macrotherium* and *Moropus* it is more saddle-shaped, due chiefly to the descending process on the dorso-ulnar angle described above. The principal articulation for the magnum is therefore confined to the posterior portion of the scaphoid, while in *Macrotherium* and *Moropus* they are located more dorsally. There is no facet for the trapezium, the radial angle of the scaphoid having no such development as in *Moropus*.

While the scaphoid of *Macrotherium* is higher than in *Nestoritherium* and has the heavy descending radial arm as in *Moropus*, it differs from the same element in the latter genus in almost every detail. The articulating surface for the radius of *Macrotherium* covers the entire superior face and is concave antero-posteriorly, while in *Moropus* the surface is plane and does not extend to the posterior face. The latter face of the scaphoid in *Moropus* as well as in *Nestoritherium* has a rugose palmar tubercle, which extends directly backward and is provided with no portion of the articular facet for the radius, while in *Macrotherium*, the palmar tubercle is directed more upward and backward with the facet for the radius well back towards the extreme posterior face. The articulating face for the lunar is confined almost entirely to the ulnar face of the distal beak-like process, the proximal portion of the bone having rather poorly defined facets for the lunar. The beak-like process appears less cube-like than in the American form and is more wedge-shaped with the apex directed backward. This process however extends downward and outward and comes in contact with the magnum in a similar manner as in *Moropus elatus*. Distally the scaphoid is taken up almost entirely by the large and obliquely concave facet for the trapezoid. There is apparently no facet for the trapezium. Altogether the scaphoid in *Macrotherium* and *Nestoritherium* is unlike that in the Titanotheres, while in *Moropus elatus* this bone is more similar to that of the Titanotheres.

Measurements of Scaphoid.

	No. 1604 (*M. elatus*), mm.	No. 1700 (*M. petersoni*), mm.	No. 1424 (*M. hollandi*), mm.
Greatest transverse diameter	54	38	40
Greatest antero-posterior diameter	62	44	52
Greatest vertical diameter	54	34	40

The Lunar (Fig. 80).—The lunar has a smaller transverse, but greater antero-posterior and vertical, diameter than the scaphoid. The articulating face for the radius is very convex antero-posteriorly and very gently convex laterally. This facet does not extend in the palmar direction as in *Titanotherium*, the palmar proc-

ess being developed only inferiorly, while in *Titanotherium* the process is somewhat bifurcated, with a heavy inferior and a lighter superior portion. Aside from the elevated portion of the palmar process in *Titanotherium* the general outline of the lunar in the two genera is not unlike. The articular facets for the scaphoid are located near the dorsal face; the upper one is on a prominent tubercle, as is well shown in Fig. 80, 3, while the one distally is sometimes divided into two portions, and fits neatly into the corresponding facet on the scaphoid described above. More distally the beak of the lunar has a large facet for the magnum, which is sub-triangular in outline. The posterior continuation of this facet for the magnum is basin-shaped and takes up the entire inferior face of the large palmar hook. This is not the case in *Titanotherium*, in which the inferior face of the palmar hook is more nearly equally divided for the magnum and unciform. On the ulnar side of the beak of the lunar in *Moropus* is an irregularly shaped facet for the unciform, which is divided into an anterior and posterior portion, by an evenly rounded transverse ridge of considerable prominence. The anterior portion is the smaller and is slightly concave transversely, convex antero-posteriorly, and subtriangular in outline, while the posterior portion is a shallow basin with more nearly triangular outlines. On the ulnar face there is one large plane facet for the cuneiform, which is D-shaped in its general outline in No. 1604. From Fig. 80, 2, it is seen that this facet is quite imperceptibly separated from the one for the unciform immediately below it. This slight separation is caused by a smooth rounded ridge, which extends antero-posteriorly and is plainly shown by the illustration. Above this facet the lunar is deeply excavated, forming a large sinus when the cuneiform is placed in contact with the lunar. In some individuals there is a minute facet for the cuneiform on the extreme upper margin, which indicates that the upper parts of the cuneiform and lunar sometimes actually came in contact with one another.

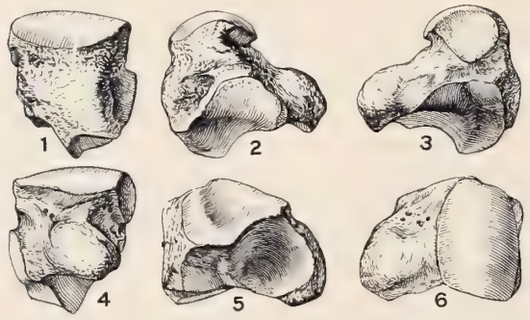


FIG. 80. Lunar of left manus of *M. elatus* (No. 1604). $\times\frac{1}{3}$. 1, dorsal, 2, ulnar, 3, radial, 4 posterior, 5, inferior, 6, superior, views.

The palmar process of the lunar in *Nestoritherium* is much shorter than in *Moropus*, but otherwise these bones in the two forms are very similar in general outline. The facets for the unciform and cuneiform respectively on the ulnar side of the distal beak are less distinctly separated in *Nestoritherium* than in

Moropus. The posterior portion of the facet for the magnum is also less deeply excavated in the former genus.

The most noticeable difference in the lunar bone of *Macrotherium*, when compared with the same bone in *Moropus elatus* or *Nestoritherium*, is detected in the almost total absence of the palmar hook in the former genus. This process, which is so prominently developed, especially in *Moropus*, is represented only by a minute eminence in *Macrotherium*. Other striking differences are manifested in the imperfect or absent proximal articular facet for the scaphoid, the ulnar position of the distal beak, and the rather small contact between the lunar and unciform in *Macrotherium* from Sansan.

Measurements of Lunar.

	No. 1604 (*M. elatus*), mm.	No. 1700 (*M. petersoni*), mm.
Greatest transverse diameter	50	41
Greatest antero-posterior diameter	68	46
Greatest vertical diameter	60	34

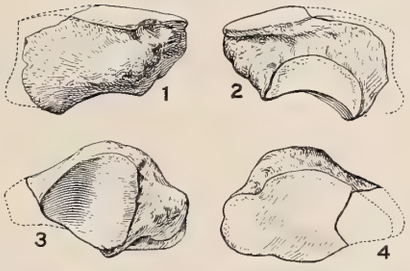


Fig. 81. Cuneiform of *M. elatus*, (No. 1604). ×⅓. 1, ulnar view; 2, radial view; 3, inferior view; 4, superior view. (Specimen somewhat defective.)

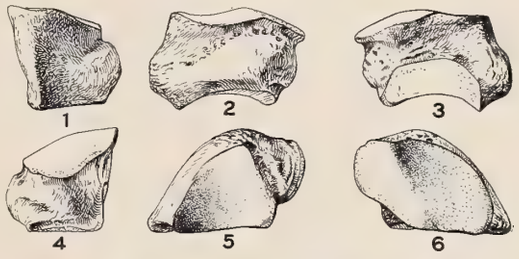


Fig. 82. Cuneiform of left manus of *M. elatus* (No. 1800). ×⅓. 1, anterior, 2, ulnar, 3, radial, 4, posterior 5, distal, 6, proximal, views.

The Cuneiform (Figs. 81–82).—In examining the illustrations, it may be noticed that the cuneiform of No. 1604 (see Fig. 81) is injured at its dorso-radial angle. By comparative measurements obtained from other individuals it is learned that the antero-posterior diameter of the cuneiform is greater than any of the carpals of the first row, while its transverse diameter is considerably less. This is illustrated in Fig. 82, where we have given a drawing of a perfect specimen (No. 1800). A great portion of the ulnar face is occupied by a prominent eminence for muscular attachments. From the anterior part of this eminence the dorso-ulnar angle tapers rapidly, forming a sharp vertical ridge of the dorso-radial border of the bone. On the palmar face there is a large ascending tubercle, which plays a prominent part in the support of the articulation for the pisiform. The proximal

face is taken up by the articular facets for the pisiform and the ulna. The facet for the ulna is gently convex transversely, concave antero-posteriorly; it occupies nearly two-thirds of the proximal face, and its general outline is a long oval. The facet for the pisiform occupies more than one-third of the proximal face; it has an elevated position on the postero-ulnar portion of the bone, and is separated from the facet for the ulna by a gently rounded ridge in a manner which gives the articular surface a wedge-shaped outline, with the postero-ulnar portion of the facet the broadest, and the apex directed dorso-radially. The radial face has, distally, a large plane facet for the lunar, crescent-shaped in outline, while proximally there is sometimes a minute facet on the overhanging proximal border, touching a corresponding small facet on the ulnar face of the lunar already described. Between these two facets the face of the bone appears to be excavated, due in a great measure to the overhanging superior border mentioned above, and which is also plainly indicated in the illustration, Fig. 82, 1, 4.

The posterior portion of the cuneiform of *Nestoritherium*, as represented by the cast, is broken off, but what remains indicates similarity to that of *Moropus*. The cast as a whole reveals a bone having relatively a smaller vertical diameter than in *Moropus*, the dorso-radial angle less sharply developed, and the articular facet for the unciform more sharply concave antero-posteriorly than in the American genus.

In *Macrotherium* the posterior part of the cuneiform is also broken off, but from the anterior portion it is very evident that the bone is quite different in its general outlines and also in minuter details. Thus the dorso-radial angle is very high proportionally and very rapidly decreases in height in the ulnar direction, due to the extremely oblique or almost lateral articular facet for the ulna. The transverse line of contact between the carpus and the ulna-radius is thus unusually convex transversely, especially on the ulnar side. In *Moropus elatus* and *Nestoritherium* the proximal articulations of the cuneiform are even somewhat less oblique than in *Titanotherium*, the facets for the ulna and pisiform of the American genus being not unlike those in the Titanotheres. The cuneiform of *Titanotherium* is, however, relatively smaller and the superior and inferior facets for the lunar are of more nearly equal size than in *Moropus elatus*.

Measurements of Cuneiform.

	No. 1604 (*M. elatus*), mm.	No. 1700 (*M. petersoni*), mm.
Greatest transverse diameter	46	30
Greatest antero-posterior diameter	69	49
Greatest vertical diameter	43	30

The Pisiform (Fig. 83).—The pisiform of No. 1604 is not present, but this element of the carpus is well represented in the abundant material in the Carnegie Museum. The pisiform of a fore foot (No. 1442) has been selected for description as it has been employed in the mounted skeleton of *Moropus elatus*. The large facet on the cuneiform for the pisiform has been referred to above and the pisiform is found to correspond in magnitude, as shown in Fig. 83. The facets for the cuneiform and ulna are sub-equal in size and are separated by a sharp ridge; the former facet is nearly parallel with the long axis of the bone, while the latter has a more oblique position. Immediately back of the facets there is a prominent swelling on the internal face, which extends from the inferior border and increases in prominence in its upward course, terminating in a large tubercle on the superior border of the bone. Back of this enlargement the shaft of the pisiform is constricted and its free end is again expanded and abruptly rounded.

The pisiform of *Nestoritherium* is very similar to that of *Moropus elatus*, but this bone is not represented in the cast of the fore foot of *Macrotherium* in the Carnegie Museum.

Measurements of Pisiform.

	No. 1442 (*M. elatus*), mm.	No. 1700 (*M. petersoni*), mm.
Greatest length	74	46
Greatest transverse diameter	34	24
Greatest vertical diameter at free end	46	33

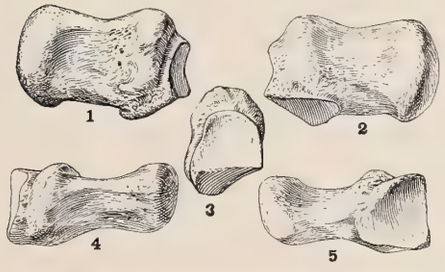


Fig. 83. Pisiform of left manus of *M. elatus* (No. 1442). ×⅓. 1, dorsal view; 2, palmar view; 3, articular view; 4, superior view; 5, inferior view.

Fig. 84. Trapezium of *M. elatus* (No. 1604). ×⅓. 1, superior view; 2, inferior view; 3, internal view; 4, radial view.

The Trapezium (Fig. 84).—The trapezium is moderately large, in shape asymmetrical and nodular. The ulnar face of the bone is taken up by a large, plane, articular surface for the trapezoid and Mc. II (see Fig. 84, 3). On the superior face of the bone is an articular facet for the scaphoid, irregularly oblong in outline (Fig. 84, 1); this facet is slightly concave laterally in order to conform with the

smoothly convex tubercle of the scaphoid, which overhangs the radial face of the trapezoid, a feature lacking in *M. hollandi* (see Fig. 12, p. 232). On the antero-ulnar angle is a third facet, which is the smallest of the three. This facet is plane (see Fig. 84, 1, 3), sub-triangular in outline, and articulates with the trapezoid on the postero-radial face of a heavy process, which projects strongly in the postero-radial direction in the trapezoid, when it is in position in the carpus. This is a second feature which does not appear in the trapezoid of *M. hollandi* (see Figs. 11 and 12, p. 232). The inferior and radial views present rough and unevenly convex faces, sub-triangular in outline, and are well illustrated in Fig. 84, 2, 4. Antero-radially the trapezium terminates in a heavy tuberosity which is abruptly rounded.

As indicated by the smooth surface of the radial face of the trapezoid and facets on the radial angle of the head of Mc. II in the cast of *Nestoritherium* there was undoubtedly a trapezium present in the foot of the animal found at Pikermi. This bone apparently did not articulate with the scaphoid as in *Moropus elatus*, due to the lack of the well-developed tubercle on the distal radial angle of the scaphoid as described above, a feature in which *Nestoritherium* and *Macrotherium* resemble *M. hollandi*.

That the scaphoid of *Nestoritherium* was able to glide over the inner face of the trapezoid to reach the head of Mc. II as suggested (*cf.* Zittel) is untenable, because (1) there are no facets indicated on the scaphoid in the cast to correspond with the small facets on the radial face of the head of Mc. II; and (2) there would be too much displacement of the entire carpus to allow such extreme flexion.

There is no trapezium present in the cast of the foot of *Macrotherium*, nor is there any apparent indication of articular facets for this element on the scaphoid or Mc. II as in *Moropus elatus* and *Nestoritherium*. From the downward continuation of the articulation of the scaphoid on the radial palmar angle it appears, however, that this element may possibly have been present in *Macrotherium*. Zittel (p. 310) states that the trapezium was reduced.

Measurements of Trapezium.

	No. 1604 (*M. elatus*), mm.
Greatest transverse diameter	28
Greatest antero-posterior diameter	46
Greatest vertical diameter	30

The Trapezoid (Fig. 85).—The trapezoid of *Moropus elatus* is of large size, as in the European genera *Macrotherium* and *Nestoritherium*. Viewed from above or below the bone is triangular in general outline (Fig. 85, 2, 3), while from other

points of view it is more quadrate in appearance. Dorsally the bone presents a heavily rugose surface, which terminates abruptly near the inferior face and is succeeded by the beak-like process of the distal articulation pointing outward, downward, and slightly overhanging the superior anterior angle of Mc. II. Superiorly the bone is almost entirely taken up by the large facet for the scaphoid, which is irregularly convex from side to side and concave antero-posteriorly. On the radial angle the transverse convexity is very pronounced and the continuation of the surface descends perpendicularly to accommodate the overhanging tubercle on the postero-radial face of the scaphoid. The facet for the trapezium is located on this vertical and broad articular surface, and is not separated above from the articulation for the scaphoid (see Fig. 85, 2, 6). On the ulnar face are two rather small facets for the magnum; one is located inferiorly and near the palmar angle, and the other is located more superiorly and in the middle of the bone nearly equidistant between the dorsal and palmar faces of the trapezoid. The two facets are separated by a large and deep excavation, the posterior facet being surrounded on three sides by this deep fossa. In front of the anterior facet is also a sinus of less depth, produced by the very prominent ridge on Mc. II, separating the trapezoid and magnum near their dorsal faces. Posteriorly the trapezoid terminates in a sharp ridge which is nearly vertical in position. On the radial side of this ridge are the facets for the scaphoid and trapezium and on the ulnar side is the rough and deeply excavated surface described above. Distally the large facet for Mc. II is divided into two nearly sub-equal portions by a sinuous and gently rounded ridge.[53] The facet as a whole has an oval outline with a concave surface antero-posteriorly and unevenly convex transversely.

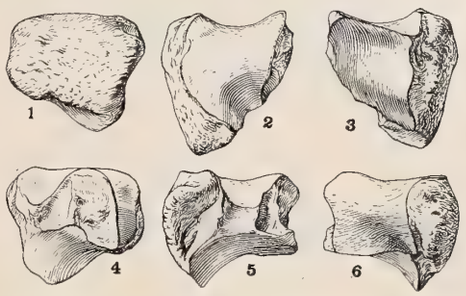


FIG. 85. Trapezoid of left foot of *M. elatus* (No. 1800). ×⅓. 1, dorsal view; 2, superior view; 3, inferior view; 4, palmar view; 5, ulnar view; 6, radial view.

The trapezoid of *Nestoritherium*, as represented by the cast, differs from that of *Moropus* in its general outline as well as in its details of structure. The dorsal face is more irregular in outline than in *Moropus*, due to the development of a broad process on the ulnar side, extending well down over the head of Mc. II. The posterior portion of the facet for the scaphoid is hemispherical in order to receive the concave facet of the latter bone, while in *Moropus* this portion of the facet is concave transversely. The articulation for the magnum is also located

[53] In some individuals this ridge is practically absent, the facet being single.

nearer the palmar border of the trapezoid in *Nestoritherium*, so that the large excavated area back of this facet seen in *Moropus* is confined to a small surface on the extreme postero-ulnar angle.

In *Macrotherium* from Sansan the outline of the trapezoid is similar to that in *Moropus*, but it is of relatively larger size and the structure of the bone is also quite different in minor details. The dorsal face of the bone in *Macrotherium* is more unevenly convex supero-inferiorly with a greater projection in the ulnar direction, though not nearly as great as in *Nestoritherium*. Radially the facet for the scaphoid, though very convex transversely and extending well down, does not reach the facet on the distal face for Mc. II as does the facet on the trapezoid of *Moropus elatus*. There was probably no trapezium in *Macrotherium*. The palmar face of the trapezoid is also much less angular both in *Macrotherium* and *Nestoritherium*.

Measurements of Trapezoid.

	No. 1604 (*M. elatus*), mm.	No. 1700 (*M. petersoni*), mm.
Greatest transverse diameter	56	48
Greatest antero-posterior diameter	55	41
Greatest vertical diameter	48	35

The Magnum (Fig. 86).—The magnum of *Moropus elatus* is of large size and has the greatest antero-posterior diameter of all the carpals. Its dorsal face is highly characteristic, having a heavy truncated protuberance which extends well dorsad and forms on the distal face a rough articular surface for the proximo-ulnar angle of Mc. II (Fig. 86, 1, 2, 3, 5, and 6), as described by Peterson (*cf.* The Am. Naturalist, Vol. XLI, p. 747 (1907)), and also well illustrated in the articulated carpus (Pl. LXVIII, Figs. 1 and 2). On the radial face are seen four articular facets (Fig. 86, 2). The largest of these facets is for Mc. II. This facet is quite irregular in outline, convex supero-inferiorly, and also slightly convex antero-posteriorly. Immediately above this facet is a deep excavation, which continues in the palmar direction and forms part of the large sinus between the trapezoid and magnum on the palmar face of the manus. Directly above the excavation mentioned is a small oblong facet for the trapezoid near the proximal angle; a second and larger facet for the trapezoid is seen immediately anterior to the excavated area, which is nearly square in outline. Continuously with, and directly above the latter facet, is the fourth facet, which is round in outline, shallow, and basin-shaped, receiving the projecting tuberosity of the scaphoid described above. On the ulnar face is a large, plane, articular surface, which is suboval in outline

and articulates with the unciform. In front and back of this articulation the ulnar face of the bone is excavated in a manner similar to that on the radial face (Fig. 86, 3). There is a palmar hook of considerable size which extends well down and helps to support the palmar portion of the large articular surface for Mc. III. On the superior face the anterior portion of the facet for the lunar lies on the ulnar side of a sharp crest (Fig. 86, 5), while farther back the surface rises and broadens, so that the posterior portion of the lunar takes up the entire postero-proximal face of the bone. The articulation for the scaphoid lies on the radial side of this crest and is described above. Distally there is one large and irregularly shaped facet for Mc. III. This facet is divided into two portions by a lateral constriction, and sometimes also by a faintly developed ridge which extends nearly directly antero-posteriorly.[54] The portion on the radial side of the ridge is the smaller and is much concave antero-posteriorly, while the larger portion of the ulnar side rises upward and outward in an oblique manner in the anterior region and descends posteriorly, forming a broad beak-like process of the palmar termination. The magnum is thus wedged in between Mc. II and III in such a manner as to impart almost complete rigidity to the bone, while its proximal surface shows more indication of flexure between magnum and lunar.

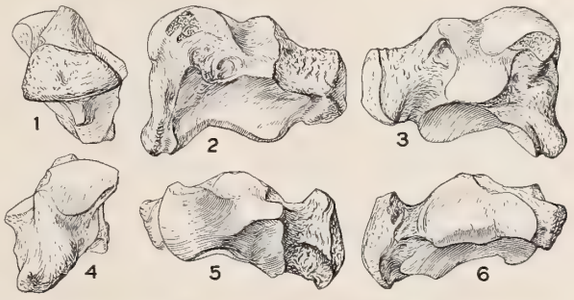


FIG. 86. Magnum of left manus of *M. elatus* (No. 1604). ×⅓. 1, dorsal, 2, radial, 3, ulnar, 4, posterior, 5, proximal, 6, distal, views.

In *Nestoritherium* the general outline of the magnum is strikingly similar to that in *Moropus*. There are differences in detail, however, of which the most noticeable is the absence of the large square facet (for the descending arm of the scaphoid (see Fig. 79, 1 and 4, p. 338)) on the proximal face at the dorso-radial angle, which is present in the American genus. The curvature of the facet for the lunar is also gentler in *Nestoritherium* than in *Moropus*.

The cast of the magnum of *Macrotherium* from Sansan employed for comparison indicates that this bone is incomplete, especially in the distal palmar region. The anterior portion, which appears to be more complete, presents a general similarity to the same bone in *Moropus elatus*, except for the absence of the large truncated tubercle on the dorsal face, which is so conspicuous in *Moropus* and *Nestoritherium*. The facet for the scaphoid in *Macrotherium* is more distinctly

[54] In No. 1604 there is evidence of this ridge.

crowded over to the dorso-radial angle, and the anterior portion of the lunar facet in consequence occupies a larger part of the anterior region and is more proximal in position than in *Moropus elatus* or *Nestoritherium*. In *Titanotherium* the magnum differs from these genera in having the superior face more nearly sub-equally divided between the scaphoid and lunar, in having the palmar portion of these facets more steeply elevated, and in having a more conspicuous palmar hook.

Measurements of Magnum.

	No. 1604 (*M. elatus*), mm.	No. 1700 (*M. petersoni*), mm.	No. 1424 (*M. hollandi*), mm.	No. 9078 A.M. (*M. matthewi*), mm.
Greatest transverse diameter	43	30	30	43
Greatest antero-posterior diameter	85	72	65	70
Greatest vertical diameter	62	36	45	57

The Unciform (Fig. 87).—The unciform is of large size, and, as in *Titanotherium*, is more or less triangular in appearance, especially when seen from above or below. The transverse diameter of the unciform is the greatest of all the carpal bones, while the antero-posterior diameter is very nearly as great as that of the magnum. The dorsal surface is rugose, somewhat excavated, and there is developed on the radial angle a large tubercle which is compressed vertically, expanded transversely, and extends well in the radial direction when in position in the carpus (Fig. 87, 3). Radially the bone has two facets of equal size; the superior, which articulates with the magnum, is nearly plane and sub-quadrate in outline; the inferior is concave antero-posteriorly, slightly convex supero-inferiorly, and articulates with Mc. III (Fig. 87, 4). Anterior and posterior to these facets this figure plainly indicates rugose excavations and two heavy processes; the larger is the dorsal tubercle described above, and the smaller is the palmar process. The superior face of the unciform is divided into two subequal articulations by a prominent ridge which extends nearly in a straight line fore-and-aft. The facet for the lunar on the radial side of the ridge is concave laterally near the radial face, but rises suddenly in the palmo-ulnar direction, so that this region of the facet is convex both transversely and antero-posteriorly, and the general outline of the whole surface is diamond-shaped. The facet for the cuneiform is subtriangular in outline and convex antero-posteriorly and slightly concave transversely, especi-

Fig. 87. Unciform of left manus of *M. elatus* (No. 1604). ×⅓. 1, proximal, 2, distal, 3, dorsal, 4, posterior, views.

ally near the dorsal margin of the facet (Fig. 87, 1). The inferior face of the unciform is occupied by the large facet for Mc. IV, which is subovate in outline. The dorsal portion of this facet occupies a lower position and is slightly convex from side to side, while farther back it rises gently and again descends near the palmar face so as to form on this portion of the facet a saddle-shaped surface. There is no facet for Mc. V on the unciform.

The unciform of *Nestoritherium*, though broad, has not the great development on the dorso-ulnar angle which obtains in *Moropus*. Furthermore, there is no true palmar process as in the latter genus, the bone being more heavily built in this region. The facet for the cuneiform descends lower down on the dorsal face than in *Moropus* and ascends more gradually to the radial palmar angle. There is no indication of a facet for Mc. V.

There is no unciform present in the cast of the manus of *Macrotherium*. In *Titanotherium* the unciform differs most prominently from that in *Moropus elatus* by having a large facet for Mc. V, a proportionally larger palmar tubercle and the dorso-radial angle less produced.

Measurements of Unciform.

	No. 1604 (*M. elatus*), mm.	No. 1700 (*M. petersoni*), mm.
Greatest transverse diameter	75	55
Greatest antero-posterior diameter	81	38
Greatest vertical diameter	57	41

The Metacarpals.

Metacarpal II (Fig. 88).—The second metacarpal is the heaviest and the shortest of the series. The proximal end has a great transverse expansion due to the heavy tuberosities on the radial and ulnar angles. The proximal end carries six facets. The first is for the trapezium and is located on the radial angle immediately back of the tuberosity on the dorso-radial angle, which is mentioned above and the tuberosity well illustrated in Fig. 88, 2. Directly proximal is a large facet for the trapezoid, which is separated from the facet for the magnum by a prominent ridge, so that the latter facet is located rather on the ulnar angle. Directly in front of this oblique facet is a second facet for the magnum, which in No. 1604 occupies the proximal face of the heavy tuberosity on the dorso-ulnar angle of the head (see Fig. 88). On the posterior face of this tuberosity is a large plane facet which is sub-quadrate in outline and articulates with a corresponding facet on the dorso-radial angle of Mc. III. Immediately back of the facet last

described is located the sixth facet, which is underneath a heavy projecting ledge on the ulnar face of the bone. This facet is quite sharply concave antero-posteriorly and articulates with a correspondingly convex facet on the proximo-radial angle of Mc. III. The head of Mc. II has a considerable palmar projection, so that the bone assumes a decidedly triangular appearance when seen from the proximal end. On the palmar and ulnar faces the bone is quite rugose immediately below the head, and on the ulnar face there is a considerable eminence on the upper half of the shaft. In general appearance the shaft is rather sub-cylindrical. There is, however, a sinuous ridge on the dorso-ulnar angle, which is perhaps somewhat too much emphasized in the illustration (Fig. 88, 2). Near the distal end there is, on the dorsal face of the shaft, a prominent and rugose swelling for muscular attachment. Distally the bone is suddenly expanded, especially in the radial and the palmo-ulnar directions.[55] The trochlea is decidedly oblique to the long axis of the shaft, the anterior portion being evenly convex in all directions, indicating a very flexible joint, as in some carnivores, while posteriorly the facets for the sesamoids are divided by a median carina, which is rather slightly developed. The facet on the radial side of the carina is concave transversely and convex antero-posteriorly, while the facet on the ulnar side is convex both antero-posteriorly and transversely, less so in the latter direction. As already stated the trochlea faces obliquely inward so that the *duplex bone* (= first and second phalanges coössified) points forward, upward, and slightly outward, when in position. The ungual phalanx again, however, points forward and inward, due to the peculiar tilt and the slight curve of the duplex bone. (See Pl. LXVIII, 1, 2.)

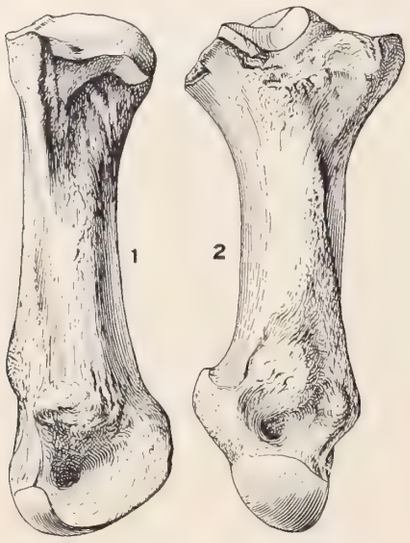


FIG. 88. Mc. II, left manus of *M. elatus* (No. 1604). ×⅓. 1, ulnar view; 2, dorsal view.

In *Nestoritherium* Mc. II is represented by the complete head and proximal portion of the shaft. The head in its details is remarkably similar to that in *Moropus*, the facet for the trapezium being smaller and the tuberosity on the dorso-ulnar angle thicker though not produced in a projecting flange articulating with the dorsal face of Mc. III as in *Moropus*. The shaft appears to be less evenly cylindrical than in *Moropus*.

The general similarity of Mc. II in *Macrotherium* to that in *Moropus elatus*

[55] The distal end of Mc. II is present in the type of *Moropus elatus* Marsh, and was identified and illustrated (Am. Naturalist, Vol. XLI, p. 735, Fig. 6) by Mr. Peterson in 1907.

and *Nestoritherium* is quite striking. It is, however, seen that the heavy tuberosity on the radial angle, near the proximal end, is relatively more prominent and extends across the entire palmar face in *Macrotherium*, while in *Moropus* and also in *Nestoritherium* it is of lighter development and ends abruptly on the radial angle, being then succeeded on the palmar face by a rough area more or less excavated. The tuberosity near the proximal end which points in the ulnar direction in *Moropus elatus* is as stated a broad flange which overlaps and articulates with the dorsal face of Mc. III, and also carries a facet for the magnum on the extreme proximo-dorsal angle. In *Nestoritherium* this flange is entirely lacking while in *Macrotherium* the tuberosity has no separate facet for the magnum; it is more cube-like, does not overlap the dorsal face of Mc. III, but articulates with that bone by lateral contacts. The shaft and distal end are still more similar to the characters met with in *Moropus*, and, as already pointed out by Professor Osborn,[56] there is no question that the animal had a sub-digitigrade foot. In fact the manus when properly articulated indicates a more digitigrade position than was given to it in Osborn's modified restoration of *Macrotherium* (*l. c.*, p. 120). In addition it may also be said that *Macrotherium* in all probability has the larger terminal phalanx on the second digit. The short and heavy metacarpal II of *Macrotherium* points, as does the same bone in *Moropus*, to the fact that it carried the heaviest terminal phalanx. In *Moropus* it has been shown that Mc. II carries the heaviest phalanges in the manus,[57] and an illustration of the manus of *Macrotherium* is given under that species (see Fig. 4) in order to show the modified position, which we believe to be correct, when compared with the manus of *Moropus*. The manus has the characteristic ungulate displacement of the carpalia in both the European and the American forms.

In comparing Mc. II of *Moropus elatus* with the cast of the corresponding bone of *Schizotherium priscum* from the Phosphorites of Quercy it is extremely interesting to note the close similarity in the two. There is practically no difference in the distal trochlea and the shaft between the European and American genera, while the facet for the trapezoid is proportionately larger and that for the magnum smaller and probably placed more laterally in *Schizotherium* than in *Moropus*.[58] In *Schizotherium* the facet for the trapezium or possibly a remnant of Mc. I[59] is

[56] American Naturalist, Vol. XXVI, 1893, pp. 118–119.

[57] Peterson, O. A., American Naturalist, Vol. XLI, 1907, pp. 746–748.

[58] From the cast it appears as though the facet for the magnum in the original bone might be broken off, in which case the facet would be larger and also occupy a similar overhanging ridge seen in the corresponding region of Mc. II in *Moropus elatus*.

[59] Filhol (Ann. des Sciences Naturelles, Tome XVI, 1894, pp. 141–144) has demonstrated that there was a Mc. I present in *Schizotherium*.

no doubt present, and the tuberosity on the radial angle is identical with that in *Moropus elatus*, as is also the tuberosity on the ulnar angle, which overlaps and articulates with Mc. III in the same manner. In the latter genus the bone as a whole is, however, relatively somewhat heavier and shorter than in *Schizotherium*. In *Titanotherium* Mc. II is flat and broad, the facet for the trapezium is present, and in some species, the articular facet for the trapezoid is large, while that for the magnum is small and placed laterally. The distal trochlea is not oblique in *Titanotherium*. Mc. II in the latter genus, while presenting some general affinities, cannot be compared with that in the *Chalicotheriidæ*.

Measurements of Second Metacarpal.

	No. 2193 Y.M. (*M. elatus*), mm.	No. 1604 (*M. elatus*), mm.	No. 1700 (*M. petersoni*), mm.	No. 1424 (*M. hollandi*), mm.
Greatest length	..	230	158	179
Greatest transverse diameter of head	..	92	66	64
Greatest antero-posterior diameter of head	..	60	43	44
Greatest antero-posterior diameter of distal end	55	67	45	38
Greatest transverse diameter of distal end	60	69	53	41

Metacarpal III (Fig. 89).—The third metacarpal is the longest in the series. The proximal end is very little expanded, while distally the bone is of much larger pro portions than the shaft both antero-posteriorly and transversely. When in position in the manus the radial portion of the head is hidden by the overlapping flange of Mc. II referred to above. On the dorsal face near the radial angle is a facet of quite large size, triangular in outline, which articulates with a corresponding facet on the posterior face of the large tuberosity on the ulnar angle of Mc. II. The anterior face of the head of Mc. III is otherwise quite rugose and irregular in outline as is shown in Fig. 89, 2. The radial face of the head has no articular facets,[60] while proximally there are three: one for Mc. II; one for the magnum; and one for the unciform. The first is the smallest of the three and is located on the proximal face of a projecting ledge on the radial angle and is convex antero-posteriorly. The second facet is the largest of the three. This facet is quite characteristic; along the radial border being a transversely narrow plane, which

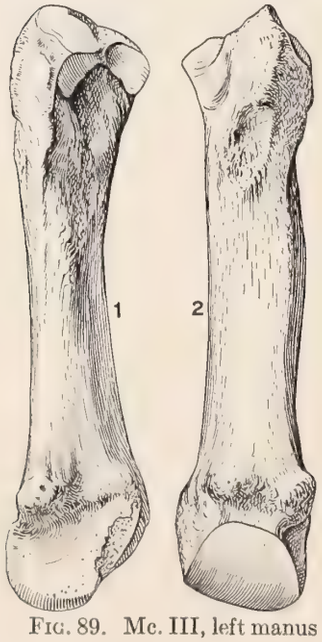


Fig. 89. Mc. III, left manus of *M. elatus* (No. 1604). $\times\frac{1}{3}$. 1, lateral view; 2, dorsal view.

[60] Occasionally there is a minute articular surface for Mc. II on the dorso-radial angle. This is not the case in No. 1604.

is convex antero-posteriorly and very soon succeeded by an oblique area, which ascends steeply upward and outward and terminates in an exceedingly high and sharp ridge, the highest point of the head of Mc. III (Fig. 89, 2). On the ulnar side of this high ridge is located the facet for the unciform. This facet is slightly concave supero-inferiorly and convex antero-posteriorly; it is sub-triangular in its general outline and is located nearer the dorsal than the palmar face of the bone. There is on the ulnar face, as in Mc. II, an overhanging projection, underneath which is located a large and obliquely placed facet for Mc. IV. A second facet for Mc. IV is located near the palmar face and is separated from the one dorsally by a narrow, but quite decided sinus, which seems to be persistent in a great number of individuals examined (see Fig. 89, 1). The surface below these facets is quite rugose for a considerable distance on the shaft, and, as on Mc. II, terminates in a slight eminence. The posterior face of the head is produced in the palmar direction, and is transversely narrow. The shaft is less cylindrical than in Mc. II, the part next to the head being sub-quadrate and the portion lower down suboval in cross-section. Distally the shaft terminates in rugosities which are especially prominent on the radial and ulnar angle of the dorsal face. The articulating surface for the proximal phalanx is very convex and is oblique, though considerably less so than in Mc. II; the carina being in a more nearly antero-posterior line with the long axis of the shaft. The radio-plantar angle of the distal end is quite curiously produced in a downward and inward direction so that the facet for the sesamoid on the radial side of the carina has an inferior position to that on the ulnar side. The carina is well developed and confined entirely to the plantar face. Judging from the oblique position of the distal articulation of Mc. III it is quite evident that the first phalanx pointed in the same direction as the first phalanx of the second digit.

As represented in the cast Mc. III of *Nestoritherium* is broken off distally. The head has a much less conspicuous ridge separating the facets for the magnum and unciform than in *Moropus*. The facet for the unciform in *Nestoritherium* occupies a more lateral position near the dorsal face continuing backward to the palmar angle in very nearly a straight line and has not the decided interlocking characters seen in this region in *Moropus* and *Macrotherium*. The shaft is also distinctly more trihedral in cross-section with a backward bend, while in *Macrotherium* the shaft is slightly curved forward, and in *Moropus* it is more nearly straight. Its anterior face is curiously flat and broad as represented in the specimen in Munich.

The general outline of Mc. III in *Macrotherium* is on the whole more similar

to that of *Moropus elatus*. The facet for Mc. II in *Macrotherium* is more lateral; the facet for the magnum is similar and the facet for the unciform is more proximal and takes up a greater space on the proximal end than that in *Moropus*. These differences give the head of Mc. III in *Macrotherium* a more cuboid appearance, especially when viewed from in front. The constriction between the articulation for the proximal phalanx and the tuberosities on the lower portion of the shaft in *Macrotherium* is relatively greater than in *Moropus*, but the shaft itself is quite similar in the two genera.

The distal end and the shaft of Mc. III in *Schizotherium priscum* more closely resemble these parts in *Macrotherium* than in either *Moropus elatus* or *Nestoritherium*, while the proximal end seems to possess characters which are found in both the European and American forms. Thus, the dorso-radial angle bears the facet for the overlapping flange for Mc. II, while the facet for Mc. II on the radial face is not as high up (or proximal) as in *Moropus* or *Nestoritherium*, nor as low, as extensive, and oblique as in *Macrotherium*. The facet for the magnum is more nearly like that in *Macrotherium*, being oblique transversely, and convex antero-posteriorly, while the small facet for the unciform, near the dorsal face and on the ulnar side of the prominent superior crest, is extremely suggestive of the facet for the same bone in *Moropus elatus*, and located in the same place on Mc. III. The overhanging ledge on the ulnar face of the head of Mc. III in *Schizotherium priscum* is much less developed than in *Macrotherium*, *Nestoritherium*, and *Moropus*.

Measurements of Third Metacarpal.

	No. 1604 (*M. elatus*), mm.	No. 1700 (*M. petersoni*), mm.	No. 1424 (*M. hollandi*), mm.
Greatest length	274	183	..
Greatest transverse diameter of head	54	42	40
Greatest antero-posterior diameter of head	55	47	49
Greatest antero-posterior diameter of distal end	56	43	..
Greatest transverse diameter of distal end	58	40	..

Metacarpal IV (Fig. 90).—The fourth metacarpal is considerably shorter than the third, the head of the latter occupying a more elevated position in the carpus and the distal end extending slightly lower down than any of the series. The proximal and distal ends are much expanded. The shaft is trihedral near the head and more cylindrical lower down, terminating distally in tuberosities like those seen on Mc. II and III. When viewed from above the general outline of the head is triangular, revealing two articular facets, which are unequally divided

by a prominent ridge, which extends across the entire antero-posterior surface between the articulations. On the radial side of this ridge quite proximally, and near the dorsal face is located one of the articular facets for Mc. III. The other facet is more lateral and nearer the palmar angle. On the ulnar side of the ridge mentioned is a large facet for the unciform, which is suboval in outline, slightly concave transversely and unevenly convex and concave antero-posteriorly. Below the head on the radial and palmar faces the shaft presents a rough surface which is sometimes developed into ridges paralleling the shaft, and serving for muscular attachments. On the ulnar palmar angle is a massive tubercle, which is bisected by a deep and broad excavation, the posterior portion being the palmar tubercle shown in Fig. 90, 2. The anterior portion of this tubercle is well illustrated in the articulated manus (Pl. LXVIII, 1, 2). At the base of these overhanging tubercles is a facet for Mc. V, which in some individuals is bisected by the downward continuation of the broad excavation described above. The facet is in an oblique position to the long axis of the shaft and is concave antero-posteriorly as well as supero-inferiorly, plainly showing that Mc. V did not articulate with the unciform, as has already been pointed out by Peterson.[61] The distal end is very like that of Mc. III except that the larger of the two protuberances, on the dorsal face, is on the radial instead of on the ulnar angle, as in Mc. III (see Fig. 90, 2).

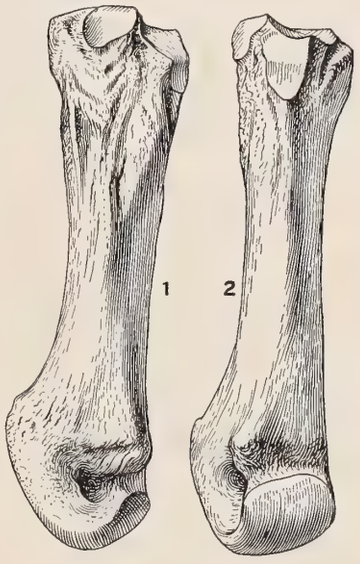


FIG. 90. Mc. IV of left manus of *M. elatus* (No. 1604). ×⅓. 1, lateral view; 2, dorsal view.

The head and the upper end of the shaft of Mc. IV in *Nestoritherium pentelici* present a number of points of difference when compared with *Moropus elatus*. For instance the articular facet for the unciform is larger and more basin-shaped, the facet for Mc. III is not divided into two portions, and there is a total absence of a facet for Mc. V. Externally the shaft of *Nestoritherium* is deeply furrowed by rugosities and the shaft itself is trihedral in cross-section with a backward bow while that of *Moropus* is more nearly cylindrical and straight.

In *Macrotherium grande* Mc. IV, though bearing a general resemblance to that of *Moropus elatus* and *Nestoritherium*, is quite unlike it in detail. In the first place this element in the remains from Sansan is the longest in the series; secondly, the palmar radial angle of the lower portions of the shaft and distal end is relatively

[61] Am. Naturalist, Vol. XLI, p. 747, 1907.

more developed than in *Moropus;* thirdly, the proximal end is less expanded, the facets for Mc. III are of proportionally greater, and the facet for the unciform of less extent than in either *Moropus* or *Nestoritherium.* There is no facet for Mc. V, that element being entirely absent as in *Nestoritherium.*

The fourth metacarpal in *Schizotherium priscum* is on the whole more nearly like that in *Moropus elatus* than in *Macrotherium* or *Nestoritherium.* The comparative length of Mc. IV in *Schizotherium* is, however, greater than in the American genus, though less than in *Macrotherium,* the latter genus having Mc. IV the longest. In *Schizotherium* and *Moropus* Mc. III is the longest. It is further worthy of note that the proximal end of Mc. IV in *Schizotherium priscum* is, as in *Moropus,* triangular in its general outline, but the facets for Mc. III are proportionally smaller and occupy a more lateral position than in the American form. The facet for the unciform is relatively larger and is more nearly triangular in its general outline than in *Moropus.* There is a distinct facet for Mc. V in *Schizotherium priscum,* which occupies a higher position on the ulnar angle than does that in *Moropus.* The proximal end of Mc. V probably came in slight contact with the unciform in the older Oligocene genus of Europe.

Measurements of Fourth Metacarpal.

	No. 1604 (*M. elatus*), mm.	No. 1700 (*M. petersoni*), mm.	No. 1424 (*M. hollandi*), mm.
Greatest length	221	154	..
Greatest transverse diameter of head	50	42	40
Greatest antero-posterior diameter of head	58	38	39
Greatest antero-posterior diameter of distal end	62	38	..
Greatest transverse diameter of distal end	55	35	..

Metacarpal V (Pls. LXVIII–LXIX).—In the manus under description Mc. V is not present. This bone is, however, represented in other individuals of the collection. No. 2462 is selected for the articulated skeleton, its size being more nearly of the right proportion. This bone is reduced to a rudiment. Proximally there are two facets for Mc. IV on the radial angle, which are separated by a smooth low ridge, the anterior facet being the larger of the two. The head quite extensively overhangs the shaft in the ulnar direction, giving a curved appearance to the shaft. Distally the bone is considerably expanded chiefly in the ulnar direction. There is an imperfect facet for the first phalanx, while on the palmar-ulnar angle is a large flat facet, presumably for a sesamoid.

As above stated Mc. V is not present in *Macrotherium* and *Nestoritherium,* while in *Schizotherium priscum* Mc. V was apparently of considerable size judging

from the facet on the ulnar face of Mc. IV in the cast of the original specimen, and also from the description and illustrations given by Filhol.

Sesamoids.—The sesamoids are of large size and vary in shape and robustness according to their position. The facets for the metapodial grooves are generally concave antero-posteriorly, irregularly convex transversely and oblong in outline. The two sesamoids on one digit often touch each other by decided facets and occasionally they are found to be solidly coössified as is sometimes the case in the *Titanotheriidæ*. They are much lighter proximally than distally, and the lateral borders of the plantar face show a rough ridge so that when the two sesamoids are placed in position there is developed between them a broad groove for the tendons. The positions which the sesamoids most probably had are best seen in the palmar view presented on Plate LXIX, Fig. 2. There were no sesamoids found located in their proper positions and the arrangement here presented must be regarded as partly conjectural pending the discovery of these parts in position, but the contacts furnished by the specimens employed are so perfect as to leave little doubt as to the correctness of the restoration given in the plate.

There are no sesamoids present in the casts of the manus of *Macrotherium* or *Schizotherium priscum* here used for comparison.

Measurements of Fifth Metacarpal.

	No. 2462 (*M. elatus*), mm.	No. 1700 (*M. petersoni*), mm.
Greatest length	140	105
Greatest transverse diameter of head	24	25
Greatest antero-posterior diameter of head	27	18
Greatest antero-posterior diameter of distal end	24	16
Greatest transverse diameter of distal end	25	21

The Phalanges.

The first and second coössified phalanges of the second digit in the manus of *Moropus elatus* are highly characteristic. The bone was described by Professor Marsh as early as 1877,[62] and again identified as the phalanges of the second digit, described, and illustrated by Mr. Peterson in 1907.[63] The proximal articulation of this duplex bone is nearly circular in outline and decidedly cup-shaped, with the ulnar border the sharper and more prominently developed. A surprising feature, showing a remarkable ability to flex the first joint of the digit, is revealed by the fact that directly anteriorly and also radially there are some-

[62] Am. Jour. Sci., Vol. XIV, pp. 249–251, 1877.

[63] Am. Naturalist, Vol. XLI, pp. 747, 1907 (illustrated, p. 735, Figs. 9, 17; p. 746, *A*).

times small emarginations which touch corresponding surfaces on Mc. II when the duplex is thrown back against the dorsal or radial faces of the metacarpal. This feature is shown in numerous specimens, in some more decidedly than in others. The proximal end of the duplex is expanded more on the ulnar side than on the radial, corresponding to the development on the ulnar angle of the distal end on Mc. II to which reference has already been made. The posterior portion of the plantar face of the duplex is taken up largely by a very broad tendinal groove. Midway between the proximal and distal ends there is, on the plantar face, a rough ridge located transversely which marks the junction of the two coössified phalanges. This ridge may be traced (see Fig. 91, 1, 2) around the entire bone and the dorsal face is seen to present a heavy elevation where the two bones are united. The distal trochlea is rather an imperfect pulley-shaped groove, there being a decided shoulder near the dorsal border of the trochlea to check the ungual phalanx when flexed dorsally (see Fig. 91, 2). Besides this dorsal shoulder there is usually a transverse ridge nearer the palmar face which interrupts the pulley-like groove and apparently rather forms a lock for the terminal phalanx. The terminal phalanx has a corresponding buttress on the proximal termination of the median keel and a cross-groove to correspond with the ridge on the duplex just described, and is thus seen to have a limited flexure. The same arrangement is found in the large Chalicothere from Pikermi.

The ungual phalanx of the second digit in *Moropus* is very heavy and its surfaces are rugose, indicating that it was covered by a heavy claw-like hoof.

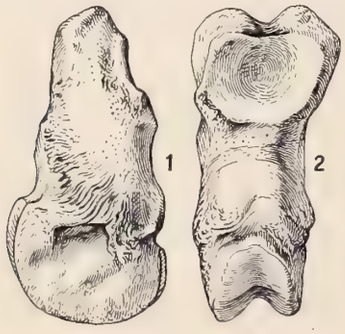


FIG. 91. Duplex bone = coössified proximal and median phalanges of digit II of left manus of *M. elatus* (No. 1604). ×⅓. 1, lateral view; 2, dorsal view.

FIG. 92. Ungual phalanx of digit II of right manus of *M. elatus* (No. 1604). ×⅓. 1, lateral view; 2, proximal view.

The bone is high, laterally compressed, not extremely long, but deeply cleft anteriorly for a firmer attachment to the horny sheath. The articulation for the duplex bone is concave supero-inferiorly and divided by a prominent median ridge, which

terminates rather abruptly proximally and fits perfectly into a corresponding shoulder of the duplex bone already described. The dorsal face is provided with a heavy protuberance, but there is no evidence of a hood such as is found on the retractile unguals of the carnivores or such as is observed in the edentates. On the proximal portion of the plantar face is a heavy subungual process, which takes up the entire face of this region and extends well below the articulation for the duplex bone. This subungual process of the proximal portion causes a fore-and-aft concavity further forward on the plantar face which is well shown in the illustration (see Fig. 92, 1). On the outer side near the inferior angle of the articulating surface a large nutrient foramen is invariably shown.

MEASUREMENTS OF DUPLEX AND TERMINAL PHALANGES OF SECOND DIGIT.[64]

Duplex Bone.

	No. 1557 Y.M. (*M. distans*), type, mm.	No. 2194 Y.M. (*M. senex*), type, mm.	No. 2193 Y.M. (*M. elatus*), type, mm.	No. 1604 (*M. elatus*), mm.	No. 1700 (*M. petersoni*), mm.	No. 1424 (*M. hollandi*), mm.
Greatest length	*60*	77	*100*	129	95	86
Transverse diameter of proximal end	28	37	...	60	40	35
Vertical diameter of distal end	..	*27*	50	66	46	44
Transverse diameter of distal end	..	22	35	43	31	25

Terminal Phalanx.

	No. 1604 (*M. elatus*), mm.	No. 1700 (*M. petersoni*), mm.	No. 9076 Y.M. (*M. Matthewi*), mm.
Greatest length	142	95	148
Greatest height	92	62	83
Greatest transverse diameter of plantar face	52	35	35

The phalanges of the third and fourth digits in *Moropus* are abruptly reduced in size. The proximal articulations for the metacarpals are circular in general outline and cup-shaped as in the duplex bone. The proximal ends are extremely heavy in comparison with the distal ends. The bones are rather asymmetrical in order to conform to the obliquely placed articular facets on the distal end of the metacarpals. As is well shown in the illustrations, the distal trochlea is confined almost entirely to the palmar face and is grooved in order to receive the phalanges of the median row. The latter are short and heavy, with a prominent median keel separating the articular facets for the proximal phalanges, while distally the grooves are more perfectly pulley-like than in the duplex bone of the second digit.

[64] Italicized numbers indicate estimated measurements.

The ungual phalanges of the third and fourth digits are similar to, though much smaller than, those on the second digit. They are sometimes quite asym-

Fig. 93. Proximal phalanx digit III, left manus of *M. elatus* (No. 1604). ×⅓. 1, dorsal view; 2, lateral view.

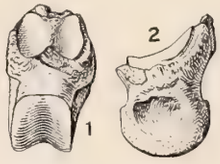


Fig. 94. Median phalanx digit III, left manus of *M. elatus* (No. 1604). ×⅓. 1, dorsal view; 2, lateral view.

Fig. 95. Ungual phalanx digit III of left manus of *M. elatus* (No. 1604). ×⅓. 1, lateral view; 2, proximal view.

metrical, one prong of the bifurcated anterior terminations being much shorter than the other. The subungual process is generally less prominent than on the second digit. The phalanges of *Macrotherium*, as described and illustrated in various publications, and also as represented in the cast of the manus here used for comparison, are heavier on the external than internal digits. This is directly opposite to the conditions found in *Moropus* and it seems that the phalanges of the manus in the European genus have been misplaced and the position assigned to them should be regarded as erroneous. As already intimated it seems altogether natural to suppose that the second metacarpal having the proportions of that of

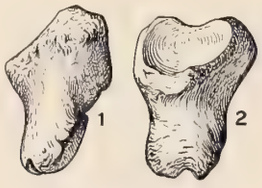


Fig. 96. Proximal phalanx digit IV, left manus of *M. elatus* (No. 1604). ×⅓. 1, lateral view; 2, dorsal view.

Fig. 97. Median phalanx digit IV, left manus of *M. elatus* (No. 1604). ×⅓. 1, superior view; 2, lateral view.

Macrotherium should have borne phalanges of larger size than those attributed to them by European authors. In *Macrotherium* the coössification between the first and second phalanges is not apparent, and the trochlea between the second and terminal phalanges is less obstructed than in *Moropus*. On the other hand in the large chalicotheroid from Pikermi the phalanges seem to be, as before stated, more nearly like those of *Moropus elatus*, with the first and second phalanges on the second digit coössified, and the duplex and terminal phalanges provided with a shoulder and buttress of nearly the same relative proportions as in *Moropus*. *Nestoritherium* is from a later horizon and is of even much larger size than the

American form. *Schizotherium priscum* is represented by the casts of a proximal and a terminal phalanx in the Carnegie Museum. The proximal phalanx is quite similar to that of *Moropus*, while the terminal is relatively broader, shorter, more widely cleft, and it undoubtedly carried a proportionally broader hoof than was found in the later forms.

Measurements of Phalanges of Third and Fourth Digits.

		No. 1604 (*M. elatus*), mm.	No. 1700 (*M. petersoni*), mm.
Proximal phalanx of third digit	Greatest length	79	59
	Greatest transverse diameter of proximal end	55	34
	Greatest vertical diameter of proximal end	48	32
	Greatest vertical diameter of distal end	26	24
	Greatest transverse diameter of distal end	26	24
Median phalanx of third digit	Greatest length	60	32
	Greatest transverse diameter of proximal end	36	23
	Greatest vertical diameter of proximal end	43	28
	Greatest vertical diameter of distal end	37	28
	Greatest transverse diameter of distal end	24	19
Terminal phalanx of third digit	Greatest length	92	55
	Greatest transverse diameter of proximal end	50?	23
	Greatest transverse diameter of plantar face	40	27
Proximal phalanx of fourth digit	Greatest length	68	45
	Greatest transverse diameter of proximal end	52	33
	Greatest vertical diameter of proximal end	46	30
	Greatest vertical diameter of distal end	24	23
	Greatest transverse diameter of distal end	32	19
Median phalanx of fourth digit	Greatest length	43	26
	Greatest transverse diameter of proximal end	32	20
Terminal phalanx of fourth digit	Greatest length	..	42
	Greatest height	..	30

The Hind Limb.

(Plates LVIII–LX; LXX–LXXI.)

The pelvic girdle has already been fully described (see pp. 320–323), in connection with the sacrum. It is therefore not necessary to more than refer to this part of the work in this connection.

The Femur.

(Plate LXX.)

The general outlines of the femur recall the same bone in *Titanotherium*. In proportion to the tibia it is, however, shorter, the head is less raised, the tro-

chanters are of larger size, the trochanteric fossa deeper, and the entire upper end of the posterior face of the shaft broader, than in *Titanotherium*. Peterson (Ann. Carnegie Museum, Vol. IV, p. 6; American Naturalist, Vol. XLI, p. 748) has called attention to the great development of the third trochanter, which is characteristic of *Moropus*, while in *Macrotherium* it is very feebly, or not at all, developed. (*Cf.* Blainville, Illustrations of *Macrotherium*, and Zittel, Handbook of Paleontology, p. 310.) The third trochanter is not as strongly developed in *M. hollandi* as in *M. elatus* and *M. petersoni*. The flat broad surface across the shaft opposite the third trochanter recalls the same feature in *Titanotherium*. Below this trochanter the shaft is greatly constricted, but nevertheless the transverse diameter is considerably greater than the antero-posterior diameter. The distal end is suddenly expanded, the condyles being of large size, and well separated by a broad and deep intercondylar notch. The rotular trochlea is not very wide, but has approximately the same obliquity as in *Titanotherium*. The pit, or supracondylar fossa, is not very deep, or distinctly marked, and is situated unusually low.

The antero-posterior and transverse diameters of the head of the femur of *Macrotherium grande* as figured by Blainville are approximately like those in *Moropus*, but the distal end of the femur in *Macrotherium* is broader, the condyles being more widely separated by a broader intercondylar notch. The rotular trochlea is also seen to be broader and shallower.

Measurements of Femur.

	No. 1706 (*M. elatus*), mm.	No. 1701 (*M. petersoni*), mm.	No. 1424 (*M. hollandi*), mm.
Greatest length of femur	650	430	500[64]
Transverse diameter of proximal end	220	133	170
Transverse diameter of head	95	66	78
Antero-posterior diameter of head	93	64	74
Antero-posterior diameter at distal end	170	102	...
Transverse diameter of distal end	170	110	125[64]

The Patella.

(Plate LXXI.)

The trochlear face of the patella strongly recalls that of *Titanotherium*, the median trochlear ridge being of approximately equal prominence, but the bone as a whole has a relatively smaller vertical and a relatively greater antero-posterior diameter than in *Titanotherium*.

[64] Approximate.

In *Macrotherium* the patella apparently has a smaller vertical diameter than in *Moropus*.

MEASUREMENTS OF PATELLA.

	No. 2193 Y.M. (*M. elatus*), type, mm.	No. 1706 (*M. elatus*), mm.	No. 1701, sp.(?), mm.
Vertical diameter	114	115	70
Transverse diameter	84	82	55
Antero-posterior diameter	64	80	41

The Tibia.

(Plate LXXI.)

The relative length of the tibia in *Moropus* is greater than in *Titanotherium*, being approximately four-fifths the length of the femur. The head is well expanded laterally, and has broad articular facets for the femur, which are separated by a prominent bifid spine. The cnemial crest is heavy, evenly rounded from side to side, and extends well down on the shaft. On the fibular angle immediately below the head is a slight rugosity, the attachment for the fibula. Below this point the transverse diameter of the shaft decreases rapidly, but the interosseous border continues as a rather sharp ridge downward to the distal end, imparting to the whole length of the shaft a subtriangular outline in cross-section, a feature less marked in *Titanotherium*, with which this bone has been compared, but similar to what may be observed in some of the early rhinoceroses, *e. g.*, *Trigonias*. The distal end of the bone in its details recalls some of the features of the same element in the skeleton of *Titanotherium*, including the broad lip-like posterior malleolus, which in some individuals touches the calcaneum on extreme flexure.

The tibia of *Macrotherium*, as figured by Blainville, and described and figured by Depéret, is very massive and short in comparison with that of *Moropus*. The head is relatively broader in *Macrotherium*, and there is therefore a more rapid decrease in the diameter of the shaft downward toward the middle of the bone than in *Moropus*, but distally the bone in *Macrotherium* appears to rapidly expand laterally, and to be broader than in the American genus.

MEASUREMENTS OF TIBIA.

	No. 1704 (*M. elatus*), mm.	No. 1701 (*M. petersoni*), mm.	No. 1424 (*M. hollandi*), mm.
Greatest length	512	353	380[65]
Antero-posterior diameter of head	150	80	...
Transverse diameter of head	168	105	118[65]
Transverse diameter of distal end	126	81	86[65]
Antero-posterior diameter of distal end	85	60	56[65]

[65] Approximate.

The Fibula.

(Plate LXXI.)

The fibula is complete, but reduced to a slender and somewhat twisted rod-like bone, with the greater portion of its shaft lying close to the side of the tibia. The proximal attachment for the tibia is not extensive, and distally the bone extends well below the tibia, articulating with the fibular face of the astragalus by a broad facet. It does not always touch the calcaneum.

The Hind Foot.

The Tarsal Elements.

(Plate LXXII.)

A great many specimens of the bones of the hind feet were found scattered through the different quarries. We mainly utilize those of the articulated skeleton for purposes of description.

The tarsus of *Moropus* is quite low and broad, but is not completely diplarthrous, the cuboid only supporting the calcaneum, and not sharing its proximal articulation with the astragalus, as in *Macrotherium grande* and other Perissodactyla. The conditions are more like those found in some of the early Tertiary forms, like *Phenacodus*,[67] or revealed in the *Litopterna* of the Miocene formations of Patagonia.[68] The metatarsals are more uniform in size than the metacarpals, and also shorter. They are quite heavy with the proximal ends much expanded, having cylindrical shafts, showing, as in the manus, at their distal ends rounded surfaces for the reception of the phalanges, succeeded on the plantar side by large facets for the sesamoids. The phalanges are short and heavy, but more uniform in size than those of the manus.

Measurements of Tarsus.

	No. 1706*a* (*M. elatus*), mm.	No. 1701 (*M. petersoni*), mm.	No. 1424 (*M. hollandi*), mm.
Greatest vertical diameter including tuber of calcaneum	186	140	130[69]
Vertical diameter top of astragalus to distal face of ectocuneiform	128	88	...
Transverse diameter	110	82	79

The Astragalus (Fig. 98).—The most characteristic feature of the astragalus is its single distal facet, that for the navicular (Fig. 98, 4), while in the true Perisso-

[67] Peterson, O. A., American Naturalist, Vol. XLI, 1907, p. 749.

[68] Scott, W. B., "Litopterna of the Santa Cruz Beds," Vol. VII, 1910, p. 7.

[69] Approximate measurement.

dactyla the distal articulation is generally divided into two portions, for the navicular and cuboid respectively. The astragalus is on the whole quite rhinocerotic, excepting the features above mentioned. In proportion it is higher and narrower than the astragalus of *Titanotherium*. The trochlea is also more deeply grooved and the external and internal condyles are more nearly uniform in size and less oblique than in the latter genus. A characteristic feature not usually found in the Perissodactyla is the downward projection of the external condyle, so that the articulation for the tibia on that side projects below the articular facet for the navicular (Fig. 98, 1). The tibial condyle has the usual backward projection met with in the Perissodactyla. The sustentacular facets are well formed and strongly interlocked. Distally there is, as previously stated, but a single large facet for the navicular which is very slightly convex transversely and concave anteroposteriorly especially near the tibial face.

In *Macrotherium* the astragalus is relatively broader and much lower than in the American form. Furthermore, its distal face is divided, having a larger facet for the navicular and a smaller for the cuboid as in other Perissodactyla (see Fig. 98, 5). The external condyle of the trochlea does not extend so low (see Fig. 98, 3)

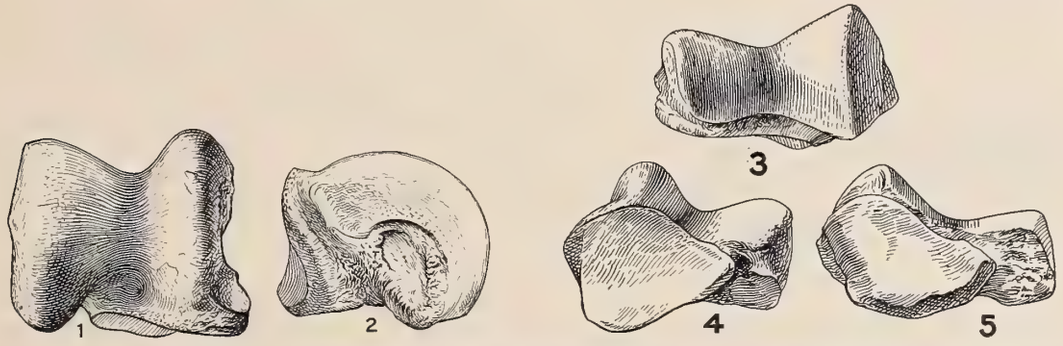


FIG. 98. *Astragalus*. 1, anterior view of right astragulus of *M. elatus* (No. 1706*A*). ×⅓. 2, lateral view of do. 3, anterior view of astragalus of *Macrotherium*. ×⅓. 4, inferior view of left astragalus of *M. elatus* (No. 1710). ×⅓. 5, inferior view of left astragalus of *Macrotherium*. ×⅓.

nor does the tibia touch the calcaneum on its extreme backward flexure as in the American genus. The fibula, however, apparently came in contact with the lateral face of the calcaneum.

Judging from the sustentacular facets of the calcaneum and the facets on the cuboid in *Nestoritherium* it may be clearly inferred that the astragalus of this large form was perhaps more nearly like that in *Moropus*, *i. e.*, the distal face articulated with the navicular only.

MEASUREMENTS OF ASTRAGALUS.

	No. 1706*a* (*M. elatus*), mm.	No. 1701 (*M. petersoni*), mm.	No. 1424 (*M. hollandi*), mm.
Greatest vertical diameter	90	68	64
Transverse diameter	96	76	83

The Calcaneum (Fig. 99).—As in other members of this group the tuberosity of the calcaneum is quite long and very heavy, while the lower end is extremely truncated. The plantar face of the tuberosity is rugose and very broad transversely, quite like that in the rhinoceroses, with gradually sloping lateral sides, giving a pear-shaped outline to the cross-section. There is no tendinal groove on the proximal end of the tuber, the extensor muscle of the foot being attached in the same manner as in other Perissodactyla. The lesser process of the distal end is developed to nearly the same extent as in *Titanotherium*, and less than in *Macrotherium*. In some individuals there is a decided facet for the tibia on the upper border of the facet for the astragalus; there is also sometimes a minute facet for the fibula on the fibular side of the greater process, and a small irregularly shaped facet below the sustentaculum near the distal angle, which articulates with a corresponding facet on the posterior face of the astragalus near the distal angle. Distally the lesser process extends downwards even with the distal end of the astragalus, so that the navicular facet of the latter bone and the cuboidal facet of the calcaneum are on nearly a horizontal line when the two bones are in position, while in *Macrotherium* and *Titanotherium* the lower end of the astragalus extends more or less below the calcaneum. The articular facets for the astragalus are large and interlocking. The surface for the interosseous ligament is prominent and forms a considerable sinus between the facets when the calcaneum and astragalus are placed in position. The facet for the cuboid is nearly plane and pear-shaped in its general outline.

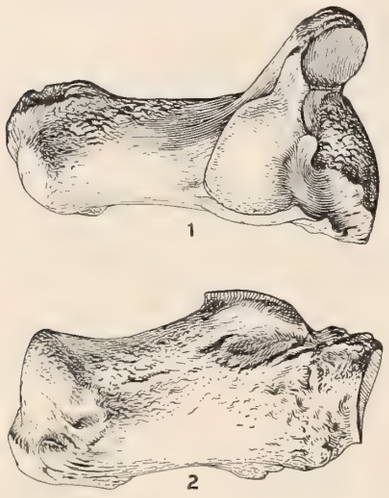


FIG. 99. Os calcaneum of right foot of *M. elatus* (No. 1706*A*). ×⅓. 1, superior view; 2, lateral view.

The remains of the calcaneum of *Nestoritherium* show strong resemblances to the same bone in the American genus. Unfortunately the tuber of the calcaneum in the specimen from Pikermi before us is not entirely complete, but what remains indicates that the plantar face is broader than the dorsal, that as in *Moro-*

pus the lateral faces of the tuber were more vertical, or nearly rectangular with reference to the sustentacular facet. The lesser process of the distal end is somewhat less developed than in the majority of the specimens representing *Moropus*, but the sustentaculum is otherwise quite similar, and the facet for the tibia at the upper angle of the facet for the astragalus is even more prominent than in any of the American forms known to us. The facets for the cuboid in the two genera here compared are not unlike.

The calcaneum of *Macrotherium* is quite different from that in the American genus. In the first place the tuber is more ovate in cross-section and oblique in position; secondly, the lesser process of the distal end is larger corresponding to the much lower and broader tarsus in *Macrotherium*. The facet for the cuboid also extends farther in the tibial direction, and the tibia, when flexed backward, did not touch the calcaneum in the latter form.

MEASUREMENTS OF CALCANEUM.[70]

	No. 2193 Y.M. (*M. elatus*, type), mm.	No. 1706*a* (*M. elatus*), mm.	No. 1701 (*M. petersoni*), mm.	No. 1424 (*M. hollandi*), mm.
Greatest length including the tuber	*155*	155	117	107
Length of tuber	90	90	77	65
Length of sustentacular facet	67	67	50	45
Transverse diameter at sustentacular facet	*93*	93	68	73

Navicular (Fig. 100).—The navicular is broad, quite deep, and thin. Its dimensions are more nearly like those of the same bone in *Equus*, than in other Perissodactyla. In detail, however, the bone differs from that of the horse in having a less developed palmar process and by the fact that the articulation for the cuboid is more extensive. The articulation for the astragalus is quite plane with the exception of the sudden upward curvature on the plantar tibial angle which is identical with the condition in *Equus*. On the fibular face there is sometimes a small facet which articulates with a corresponding facet on the tibial face of the cuboid. The main facet for the cuboid is long antero-posteriorly and narrow

FIG. 100. Navicular of right foot of *M. elatus* (No. 1706*A*). ×⅓. 1, anterior view; 2, fibular view, showing facet for cuboid; 3, posterior view; 4, tibial view, face for mesocuneiform; 5, inferior view, surfaces for cuboid and cuneiforms; 6, superior view, face for astragalus.

[70] Italicized numbers estimated.

transversely and is situated near the distal angle of the bone (see Fig. 100, 2). Distally there are two distinct facets; the larger of the two is triangular in outline, quite plane, and articulates with the ectocuneiform, while the outline of the smaller is more ovate, slightly convex antero-posteriorly, and articulates with the mesocuneiform. The illustration (Fig. 100, 5) indicates a third facet, that for the cuboid, on the fibular angle. There is apparently no facet for the entocuneiform. Directly posteriorly the navicular terminates in a rounded process, which is, as before stated, directed upward and backward, like that in the posterior tibial angle of the navicular in the horse.

There is no navicular in the specimens of *Nestoritherium* in our material, but from the shape and position of the facet for this bone on the tibial proximal angle of the cuboid it is quite evident that this bone was much the same as in the genus *Moropus*.

The navicular of *Macrotherium* is even thinner, and it is more sharply turned upward on its plantar face than in *Moropus*. The articulation for the cuboid is also apparently less prominent than in the American form.

Measurements of Navicular.

	No. 1706*a* (*M. elatus*), mm.	No. 1701 (*M. petersoni*), mm.
Antero-posterior diameter	55	41
Transverse diameter	74	54
Vertical diameter	15	10

Cuboid (Fig. 101).—The cuboid is low and broad as in *Titanotherium*. The bone, however, differs from that in the latter genus in an important manner, having but one proximal articulation, that for the calcaneum, as already pointed out by Peterson (*l. c.*, p. 749). In all other Perissodactyla the astragalus shares the support of the cuboid to a greater or less extent, and this is also the case in *Macrotherium*. In *Nestoritherium* as in *Moropus* the cuboid did not have an articular facet for the astragalus. Dorsally the cuboid in *Moropus* has a rather cube-like appearance, the lateral borders (especially the fibular) being quite angular. The tibial face is the longest, which is chiefly due to the prominent plantar process. Proximally there is, as before stated, one facet for the calcaneum which is ovate in general outline, slightly concave antero-posteriorly, and again sharply deflected on the extreme plantar angle, while transversely it is very gently convex. On the tibial face are two facets, one superior and the other inferior to a prominent ridge projecting in the tibial direction. Both facets are long antero-posteriorly and narrow transversely, the superior facet articulates with

the navicular and the inferior with the ectocuneiform.[71] Distally there is one large facet, subtriangular in outline, slightly convex antero-posteriorly and concave laterally. On the plantar face there is an unusually heavy tuberosity for muscular attachment. (See Fig. 101, 2, 3, 5, and 6.)

In *Nestoritherium* the cuboid is actually and proportionally lower, the proximal articulation less concave antero-posteriorly, the distal articulation more unevenly convex and concave, the navicular articulation deeper vertically and shorter antero-posteriorly than in *Moropus*. With the exception of the above noted differences the cuboid in the Greek and American forms is very similar, especially agreeing in the fact that in both genera the bone does not touch the astragalus.

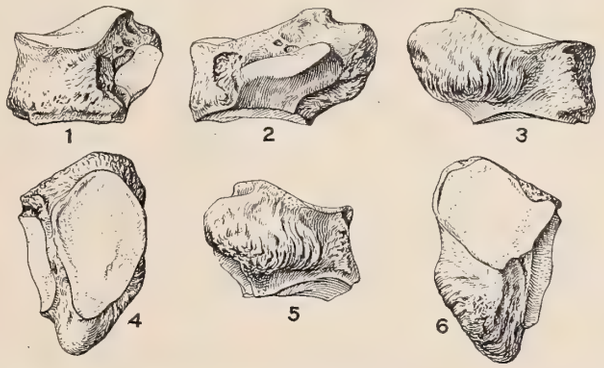


FIG. 101.- Cuboid of the right foot of *M. elatus* (No. 1706*A*). ×⅓. 1, anterior view; 2, tibial surface; 3, fibular surface; 4, superior view; 5, posterior view; 6, inferior view.

In *Macrotherium* the cuboid is entirely different from that in *Moropus*. In the first place it partly supports the astragalus which it does not in the other genus; secondly, its fibular angle is very low, while it is quite high in the American form, and thirdly, the plantar process is extremely small, while in the tibial direction the bone is modified, forming a long heavy arm, which supports the lesser process of the calcaneum, a feature entirely unknown in *Moropus*.

MEASUREMENTS OF CUBOID.

	No. 3081 Y.M. (*M. distans*, type), mm.	No. 1706*a* (*M. elatus*), mm.	No. 1701 (*M. petersoni*), mm.
Antero-posterior diameter	45	85	49
Transverse diameter	31	55	37
Vertical diameter	25	37	25

Ectocuneiform (Fig. 102).—The ectocuneiform is sub-triangular in general outline, low, and broad; its transverse diameter being proportionally greater than in *Titanotherium*. The bone is especially prominent in the tarsus, due to its broad dorsal surface. Proximally the facet for the navicular is concave antero-

[71] These facets vary in different individuals, sometimes there is an additional facet for the navicular on the proximal angle near the dorsal face, and the facet for the ectocuneiform is sometimes divided into two portions, an anterior and a posterior.

posteriorly and quite plane transversely. The facet for the cuboid on the fibular face is well formed, long antero-posteriorly, quite shallow vertically, with its articulating surface curved[72] in order to conform to a similarly curved surface on the cuboid already described. Below the articular surface near the plantar face is a prominent excavation (Fig. 102, 5) which is directly opposite a similar excavation on the cuboid and causes a deep cavity to be formed on the plantar face of the tarsus when the bones are in position. On the tibial face are three facets, a dorsal and a plantar, which articulate with Mt. IV; the third is longer and narrower and situated near the proximal angle, articulating with the mesocuneiform. The plantar face is principally taken up by a prominent tuberosity. Distally the articulation for Mt. III is triangular in outline, irregularly, but gently, convex and concave.

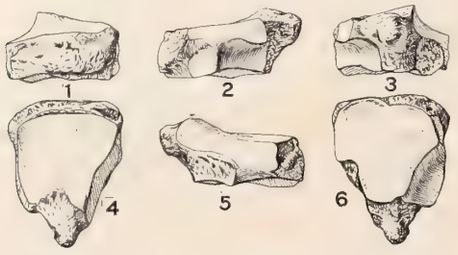


FIG. 102. Ectocuneiform of the right foot of *M. elatus* (No. 1706*A*). ×⅓. 1, anterior view; 2, tibial surface; 3, posterior view; 4, superior view; 5, fibular surface; 6, inferior surface.

MEASUREMENTS OF ECTOCUNEIFORM.

	No. 1706*a* (*M. elatus*), mm.	No. 1701 (*M. petersoni*), mm.
Antero-posterior diameter	60	45
Transverse diameter	45	34
Vertical diameter	10	12

Mesocuneiform (Fig. 103).—The mesocuneiform is much reduced; it is somewhat more reduced than in *Titanotherium* and has a slightly greater vertical diameter than in the latter. The dorsal face is very small and triangular in outline. The tibial face is rugose and quite extensive, the bone having a considerable anteroposterior diameter. The plantar face is broader than the dorsal, and there is a small round facet for the entocuneiform on the tibial plantar angle. The facet for the navicular is oblong in outline, concave antero-posteriorly, and also slightly concave laterally. The fibular face has a long narrow facet for the ectocuneiform. Distally there is one large facet for Mt. IV, which is triangular in general outline, and unevenly concave and convex.

FIG. 103. Left mesocuneiform of *M. petersoni* (No. 1813). ×⅓. 1, fibular view; 2, tibial view; 3, superior view; 4, inferior view.

Entocuneiform.—A characteristic feature of *Moropus* is the obsolescence of the entocuneiform as in *Titanotherium*. In our material prepared for study there

[72] This surface is sometimes interrupted so as to form a facet in front and behind.

has not yet been found a bone which can positively be recognized as an entocuneiform, but, judging from the fact that the navicular of many individuals shows no articular surface for the entocuneiform, and also that Mt. II seldom shows any indication of a contact with this element, it is very evident that the bone was only a small sesamoid, or was entirely wanting. In *Eomoropus* from the Washakie Eocene the entocuneiform is present but has no facet for Mt. I.

In the material representing *Macrotherium grande* at our command there are no cuneiforms. In *Nestoritherium* on the other hand the ecto- and mesocuneiforms are represented. In the casts used these bones adhere to Mt. III and IV respectively. In proportions and details these two bones are remarkably similar to the same elements in the American genus *Moropus*.

Measurements of Mesocuneiform.

	No. 1706*a* (*M. elatus*), mm.	No. 1701 (*M. petersoni*), mm.
Antero-posterior diameter	40	38
Transverse diameter	23	22
Vertical diameter	20	14

Metatarsal II (Fig. 104).—The proximal end of the second metatarsal is very little expanded especially in the lateral directions. The actual length of the bone is very little less than that of Mt. III, but in the tarsus it appears quite short on account of the elevation of its head above that of the latter (Pl. LXXII). The head has four articular surfaces. One directly superior for the entocuneiform and the other three on the fibular side articulating with the ectocuneiform and Mt. III. The first is concave antero-posteriorly, slightly concave laterally, and corresponds with the evenly convex distal surface of the mesocuneiform. The lateral facets are of an interlocking nature and below the articulations there is a rugose eminence for cartilaginous attachment which takes up the entire fibular face of the bone (see Fig. 104, 1). The dorsal and tibial faces are quite rugose, while plantarly there is a protuberance which extends across the entire plantar face of the head. The shaft is rather short and heavy; it is cylindrical, but with a rugose ridge extending from the plantar tibial angle of the head to the middle region of the shaft, well illustrated in Fig. 104, 3. Distally the bone is more expanded than proximally, with the anterior portion of the trochlea hemispherical

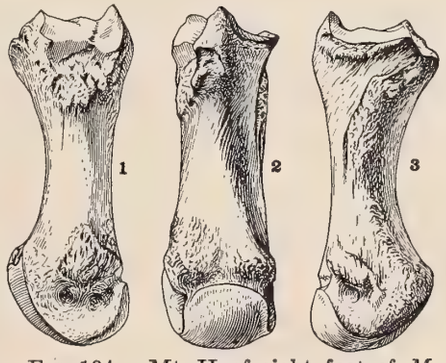


Fig. 104. Mt. II of right foot of *M. elatus* (No. 1706*A*). ×⅓. 1, fibular side; 2, dorsal side; 3, tibial side.

as in the metacarpals, and separated from the shaft by a prominent groove which terminates in pits on either side of the trochlea, not unlike what is seen in the carnivores. Plantarly there are the usual large surfaces for the sesamoids which are separated by a heavy keel. The latter extends well down and is abruptly terminated by the hemispherical surface on the dorsal face.

In *Nestoritherium* the second metatarsal is relatively shorter than in *Moropus*. The shaft is also more trihedral, chiefly due to the greater development of the fibular face and the dorso-tibial angle of the shaft. Distally the metapodial keel is less prominent, and the trochlea somewhat more oblique than in the American form.

In *Macrotherium* the metatarsals are relatively shorter and heavier than in *Moropus*. In the former the head of Mt. II rises above that of Mt. III as in the latter, but the articulation for the mesocuneiform is more cup-shaped, and the facet for the ectocuneiform takes up a larger portion of the proximal end. Furthermore, the lateral articulation is less interlocking in the European form due to the absence of the prominent arm at the dorso-tibial angle (see Fig. 104, 2). In *Macrotherium* the shaft is broader transversely while the distal trochlea is quite similar to that in *Moropus*. In the former the trochlea is, however, less distinctly separated from the shaft dorsally than in the latter genus.

In *Schizotherium priscum* Mt. II is apparently slenderer than in either *Chalicotherium*, *Macrotherium*, or *Moropus*.[73] Proximally the head is rather compressed laterally and not much expanded antero-posteriorly. It would appear that there was an entocuneiform of considerable size in the tarsus of this early genus, judging from the margin of what appears to be an articular facet of considerable size on the injured (?) tibial face of the head.[74] The shaft is somewhat less cylindrical than in *Moropus*, while the distal trochlea is quite similar.

MEASUREMENTS OF SECOND METATARSAL.[75]

	No. 2193 Y.M. (*M. elatus*, type), mm.	No. 1706*a* (*M. elatus*), mm.	No. 1701 (*M. petersoni*), mm.	No. 9368 *A*.M. (*M. matthewi*), mm.
Length	134	137	105	123
Antero-posterior diameter of head	49	48	39	46
Transverse diameter of head	36	40	*30*	50
Transverse diameter of distal end	38	46	30	48
Antero-posterior diameter of distal end	41	48	35	48

[73] Mt. II, which Filhol associates with the pes of *Schizotherium*, is probably not of the same individual.

[74] In consulting Filhol (Observations concernant Quelques Mammifères Fossiles Nouveaux Du Quercy, Ann. Sci. Nat. Zool. et Pal., Tome XVI, 1894, p. 147) it would appear that this surface is caused by a pick used in excavating the specimen.

[75] Italicized numbers represent estimated measurements.

Metatarsal III (Fig. 105).—The head of Mt. III is more expanded than that of Mt. II, which is chiefly due to a heavy process pointing in the fibular direction not unlike the process on the dorso-ulnar angle of the head of Mc. III, and also to the prominent tuberosity on the plantar face. The fibular face has two articulations for Mt. IV, a large one on the process near the dorsal face, and a smaller one on the fibular face of the plantar process. The two facets together form a conspicuous antero-posterior concavity, which fits corresponding facets on Mt. IV, and forms a most effective interlocking articulation when the two bones are in position. This condition is entirely unlike that in *Titanotherium*, in which the lateral facets on Mt. III and IV are rather small, and not of an interlocking nature. In the latter genus, however, the cuboid reaches over and articulates with a considerable portion of the head of Mt. III, and in this way interlocks these two bones of the pes which is not the case in *Moropus*, the latter showing conditions more nearly like those in the true Rhinoceroses. The tibial face of the head has an unevenly convex articulation for Mt. II, which is situated on a large eminence and fits into a corresponding groove on the fibular face of the head of Mt. II, already described. The articulation for the ectocuneiform is plane, triangular in general outline, and of considerable obliquity, due to the ascent of the large process on the fibular angle (see Fig. 105, 2). As in Mt. II the shaft is cylindrical and the distal trochlea also assumes the same general characters.

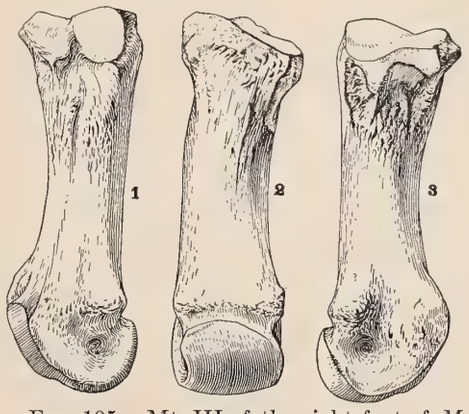


FIG. 105. Mt. III of the right foot of *M. elatus* (No. 1706*A*). ×⅓. 1, fibular view; 2, dorsal view; 3, tibial view.

One of the more important generic characters of *Nestoritherium pentelici* is found in the relative length of the metatarsals. In *Macrotherium* Mt. IV is the longest, in *Moropus* and *Schizotherium* Mt. III and IV are of subequal length, but in *Nestoritherium* Mt. III is decidedly the longest, a character more nearly resembling the conditions in *Titanotherium* than in any of the Chalicotheres, in which this portion of their anatomy is known. Proximally the head carries only one facet, that for the ectocuneiform, exactly as in *Moropus* and *Schizotherium*. In *Nestoritherium* the details of the head are very nearly as they are in the American form; the shaft, however, is broader transversely, the dorsal face of the trochlea somewhat less hemispherical, and the carina less prominent.

Beside the relatively shorter Mt. III in *Macrotherium* it has even a greater

obliquity to the ectocuneiform articulation, and, as in *Titanotherium*, the cuboid articulates with the fibular portion of the head. The shaft of Mt. III in *Macrotherium* is broad transversely, and not round as in *Moropus*.

Measurements of Third Metatarsal.[76]

	No. 2193 Y.M. (*M. elatus*, type), mm.	No. 1706*a* (*M. elatus*), mm.	No. 1701 (*M. petersoni*), mm.	No. 9077 A.M. (*M. matthewi*), mm.
Length	..	156	122	122
Antero-posterior diameter of head	54	53	40	*47*
Transverse diameter of head	45	48	*48*	*43*
Transverse diameter of distal end	..	45	39	48
Antero-posterior diameter of distal end	..	54	38	48

Metatarsal IV (Fig. 106).—The head of Mt. IV is square in outline. Proximally there is a large, nearly plane facet for the cuboid. The fibular and plantar faces are considerably expanded due to heavy rugosities and protuberances. On the tibial face are two facets for Mt. III, which are conspicuous because situated on these projections, so that, when the metatarsals are placed in position, the lateral faces of the shafts are entirely separated (see Plate LXXII). The shaft is less cylindrical than in Mt. III. This is chiefly due to a heavy and rugose ridge which extends from the head throughout the entire length of the shaft on the fibulo-plantar angle. The distal end of the bone points slightly in the tibial direction, due to the curvature of the shaft (see Fig. 105, 2). The trochlea has a greater obliquity than in Mt. III; otherwise there is very little difference in the details of the two metatarsals here compared.

Fig. 106. Mt. IV of right foot of *M. elatus* (No. 1706*A*). ×⅓. 1, fibular view; 2, dorsal view; 3, tibial view.

Mt. IV in *Macrotherium* is conspicuously the longest, while in *Moropus* it is very little, if any, longer than Mt. III. In *Macrotherium* the facet for the cuboid is more concave due to the raised fibular and plantar borders; the outline of the articular surface is more nearly square; while the distal trochlea has about the same degree of obliquity as in the American form.

In *Nestoritherium* Mt. IV is fully as heavy as Mt. III, but considerably shorter, as previously stated. The facet for the cuboid is somewhat more oblique than in *Moropus*, which is entirely due to the more elevated tibio-plantar angle of the

[76] Italicized numbers represent estimated measurements.

form from Pikermi. The facet for Mt. III situated near the dorsal angle is quite large, while the one on the plantar face is apparently obsolescent as in *Macrotherium* and is thus unlike the well formed facets located on the lower side in *Moropus* and *Schizotherium*.

MEASUREMENTS OF FOURTH METATARSAL.[77]

	No. 1706*a* (*M. elatus*), mm.	No. 1701 (*M. petersoni*), mm.
Length	157	123
Antero-posterior diameter of head	48	35
Transverse diameter of head	57	*35*
Transverse diameter of distal end	49	34
Antero-posterior diameter of distal end	53	38

The Sesamoids of the Pes.—The sesamoids of the hind feet are similar to those of the fore feet, and one of them is shown in the accompanying figure (Fig. 107).

The Phalanges (Figs. 108–115).—The uniformity in size of the metatarsals is also carried out in the phalanges. The latter are more uniform in size than

FIG. 107. Sesamoid of Mt. IV, right pes of *M. elatus* (No. 1706*A*). ×⅓. 1, articular surface; 2, tibial side; 3, posterior view; 4, fibular side.

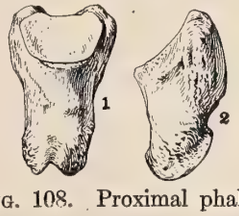


FIG. 108. Proximal phalanx of digit II, right pes of *M. elatus* (No. 1706*A*). ×⅓. 1, superior view; 2, lateral view.

FIG. 109. Median phalanx of digit II, right pes of *M. elatus* (No. 1706*A*). ×⅓. 1, dorsal view; 2, lateral view.

in the manus. Furthermore, the proximal phalanges of the pes have less expanded proximal ends, but the structure in detail is otherwise similar to that in the manus. The median and ungual phalanges are also similar in detail in the fore and hind

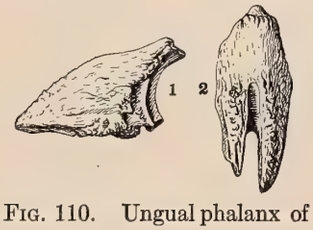


FIG. 110. Ungual phalanx of digit II, right pes of *M. elatus* (No. 1706*A*). ×⅓. 1, lateral view; 2, anterior view.

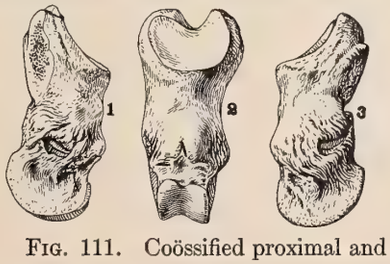


FIG. 111. Coössified proximal and median phalanges of digit II of right pes of *M. elatus* (No. 1706*A*). ×⅓. 1, fibular, 2, dorsal, 3, tibial, views.

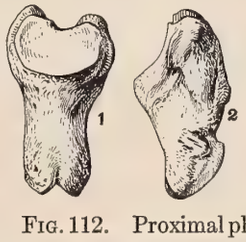


FIG. 112. Proximal phalanx of digit III of right pes of *M. elatus* (No. 1706*A*). ×⅓. 1, anterior view; 2, tibial view.

[77] Italicized numbers represent estimated measurements.

feet. A typical feature of the genus is seen in the separated first and second phalanges of all the digits. In the extensive material in the Carnegie Museum there is, however, occasionally found a coössified first and second phalanx of the pes; a character of individual variation or possibly old age (see Fig. 111).

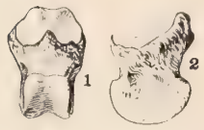


FIG. 113. Median phalanx of digit III, right pes of *M. elatus* (No. 1706*A*). ×⅓. 1, dorsal view; 2, lateral view.

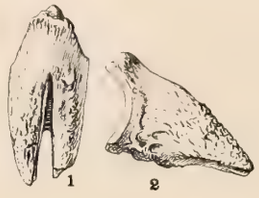


FIG. 114. Ungual phalanx of digit III of right pes of *M. elatus* (No. 1706*A*). ×⅓. 1, dorsal view; 2, lateral view.

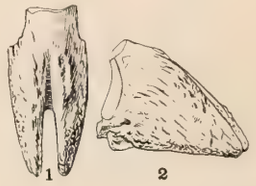


FIG. 115. Ungual phalanx of digit IV of right pes of *M. elatus* (No. 1706*A*). ×⅓. 1, dorsal view; 2, lateral view.

As represented in the cast of the hind foot of *Nestoritherium pentelici*, the three phalanges of the fourth digit are all present. They are proportionally somewhat shorter and broader than in *Moropus*, but more closely suggest the latter than the same bones in *Macrotherium*. Judging from the cast, these bones appear to be coössified, which is not at all surprising in view of the tendency toward coössification of the phalanges in *Moropus* from an earlier formation.

In *Macrotherium* the proximal phalanges are shorter, much more depressed, and broader, and the terminals are larger in proportion than in *Moropus*. The proximal and median phalanges are not coössified; the articulations, however, indicate that had we a number of individuals, there would undoubtedly be found cases of coössification of these two bones in *Macrotherium*.

MEASUREMENTS OF PHALANGES.

	No. 1706*a* (*M. elatus*), mm.	No. 1701 (*M. petersoni*), mm.
Length of a first phalanx, 2d digit	68	50
Length of first and second phalanges	83	..
Length of terminal phalanx of 3d digit	84	40
Height of same phalanx	45	31

ARTICULATED SKELETON AND RESTORATION OF MOROPUS ELATUS MARSH.

Plates LXXIII–LXXVII.

The articulated skeleton of *Moropus elatus* presents many unique features. Perissodactyl characters predominate when the skeleton is viewed as a whole, but in detail there are a number of anomalous features, among which the structure

of the phalanges, the distal end of the metapodials, the lower end of the humerus, and the length of the ischium are the most noticeable. The head is that of a Perissodactyl combining various features represented in the horse, the rhinoceros, and the tapir, as has been already pointed out in the foregoing pages. The neck is perhaps most like that of the horse, though heavier. The thorax and the lumbar region are suggestive of the Rhinoceroses in general appearance, while the dorso-lumbar region, in the number of its vertebræ, is more like *Titanotherium*. The hind limbs are especially like those in the latter genus, except that the pelvis is much longer. The scapula is also very large and in this respect suggests *Titanotherium*, but it is on the whole more like that of the Rhinoceroses in its general outlines. The humerus has a curiously primitive appearance, the distal end being especially suggestive of the conditions met with in early Tertiary forms (*Phenacodus*, etc.). The ulna-radius is highly modified, much elongated, and often coössified throughout. The carpus is completely diplarthrous, while the tarsus is nearly so (the distal face of the astragalus articulating with the navicular only). The upper ends of the metapodials are of the ungulate pattern, while distally they present the anomaly of being more nearly like those of a carnivore, in order to conform to the curiously modified phalanges. The body is heavy as are the limbs and the feet, especially the fore feet, while the head is rather small in proportion. In *Moropus* the fore limb is longer than the hind limb, but not to the same degree as appears to be the case in *Macrotherium grande* according to illustrations given by different authors.

As has been stated in an earlier publication (*l. c.*, p. 742) the vertebral column as well as the ribs, and the fore limbs and feet represent but one individual. The hind limbs and feet were found a short distance from where the main portion of the skeleton was discovered (see Fig. 2) and are associated with the skeleton under a separate number (No. 1706). This association is established because the pelvis and hind limb appear to agree with the rest of the skeleton and it is altogether probable that they pertain to the same individual.

The restoration of the skeleton shown in the plates has been most skilfully effected by Mr. S. Agostini under the supervision of Mr. Peterson.

MEASUREMENTS OF THE MOUNTED SKELETON.

	Mm.
Total length from the end of the lower jaws to ischial tuberosity	2,950
Length of cervical region	810
Length of dorsal region	860
Length of lumbar region	450
Length of sacrum, approximately	200

Greatest transverse diameter at the heads of the humeri	640
Greatest transverse diameter of the thoracic cavity at 10th rib	670
Height at withers or second dorsal vertebra	1,860
Height at last lumbar vertebra	1,700
Height at point of ilium	1,520
Height at ischial tuberosity	1,060
Length of sternum, approximately	780
Length of tail, approximately	720

In concluding this memoir it may be said that the study of the various portions of the skeleton outlined in the previous pages shows very clearly the fact that *Moropus* was a highly aberrant Perissodactyl, in some portions of its bony framework revealing affinities with the horses, Titanotheres, and Paleotheres, but quite distinct from all these and representing a wholly independent line of evolutionary development. The opinion has long been held that the Chalicotheres were European in their origin, as until recently the oldest remains representing them came from that part of the world. The recent determination by Professor Osborn of *Triplopus amarorum* Cope as a Chalicothere from the Washakie Eocene, shows us that these animals existed at about as early a date on the soil of the New as on that of the Old World. If Prof. Osborn is correct in his view—and apparently there is no reason to call in question his judgment—the origin of the family is found far back in the early Tertiaries of both the great land masses. Where the initial point of development was, is, however, still left in obscurity, though *Eomoropus* seems to reveal characters which are nearly as primitive as those which are revealed by what little we possess of the skeletal remains of the earlier European genera. A vast amount of exploration and research must still be performed before the evolutionary history of this family can be regarded as having been placed upon an approximately sound basis.

CHAPTER VI. BIBLIOGRAPHY.

The following list of papers, which are arranged alphabetically according to authors under the year of publication, cites the more important contributions which have been made to the literature and discussion of the subject with which this Memoir deals. It is not necessarily complete, the author not having been able to devote to its compilation as much time as he would have liked to bestow; but, though there are no doubt omissions, it fairly represents the literature to which the student of the subject requires to have access.

1825.

Cuvier, Baron Georges—"*Sur une phalange ongueale fossile qui annonce à elle seule un Edenté inconnu, probablement du genre des Pangolins, et de taille gigantesque.*"

Recherches sur les Ossemens Fossiles, Tome V, Ire Partie, pp. 193–195. 3me Edition, 1825.

In this paper Cuvier describes the cast of an ungual phalanx found at Eppelsheim, Germany, and refers it unhesitatingly to the Edentata, pointing out its similarity to the claw of *Orycteropus*.

1833.

KAUP, JOHANN JAKOB—"*Ossemens Fossiles de Darmstadt*," 2me Livraison, p. 6, Pl. 7.

The author gives the name *Chalicotherium goldfussi* to an animal, which in the first Livraison of the same work he had designated as *Lophiodon goldfussi*, and describes *Chalicotherium antiquum*.

1837.

LARTET, ÉDOUARD A. I. H.—"*Note sur les ossements fossiles des terrains tertiaires de Simorre, de Sansan, etc., dans le département du Gers, et sur la découverte récente d'une machoire de singe fossile.*" Comptes Rendus des Séances de l'Académie des Sciences, 1837, T. IV, pp. 85–93.

Mons. Lartet in his communication (*l. c.*, p. 90) says: "The order Edentates was represented in our Tertiary fauna by a very large quadruped, of which I am only able to deposit in the Museum two or three phalanges and one tooth in very bad condition." . . . "M. Cuvier was acquainted with one ungual phalanx of this same edentate which had been found upon the banks of the Rhine; and this great naturalist was led by its form to refer it to a *Pangolin gigantesque*, to which, judging from proportions, he assigned a length of twenty-four feet."

"The claws of our edentate are like those of pangolins, cleft in front and without an osseous sheath, but they are proportionately higher, less elongated, and slenderer. Before speaking of the differences shown by other portions of the extremities, I may recall that our animal had at least some molar teeth, a fact which separates it altogether from the pangolins."

"These teeth,[1] formed of not very compact ivory, were without roots and entirely devoid of enamel. They projected but little from the alveoli, and their method of reciprocal action resulted in crushing rather than grinding their food; the result being a method of mastication too imperfect to allow us to suppose that the animal was herbivorous. For the same reason, if it fed upon flesh, it could only have been the carcasses of dead animals; fruits and insects remain to be suggested as its possible aliment. The form of the radio-humeral articulation would indicate that our edentate was able to some extent to execute the movement of supination."

"The articulation of the fingers of this edentate reveals a singular anomaly: the first phalanx of each finger, placed horizontally in respect to its length, receives the

[1] The teeth described by Lartet were subsequently shown by Filhol and Depéret to be the roots of the broken teeth of a mastodon of small size.

head of the corresponding metacarpal not end to end, as in other quadrupeds, but in a cavity excavated in its upper surface and considerably enlarged posteriorly. This cavity, which is quite deep, is rounded and marked at its posterior border by a depression, over which plays the median ridge, which does not appear until the back of the head of the metacarpal is reached. This mode of articulation, causing the whole weight of the body to be carried upon the broad base provided by the anterior phalanges, would greatly aid the animal in walking by decreasing the embarrassment occasioned by its enormous claws, which we may believe to have been habitually bent underneath. It is possible to form a conception of the effect produced in this way by imagining a man walking upon his toes, the soles of the feet being raised a little, and the big toes bent backward." (Translation W. J. H.)

Lartet, Édouard A. I. H.—"*Sur les débris fossiles trouvés a Sansan, et sur les animaux antediluviens en général.*" Extrait d'une lettre de M. Lartet à M. Flourens. (Commissaire M. de Blainville.) Comptes Rendus des Séances de l'Académie des Sciences, 1837, T. V, 158–9.

On page 159 it is stated that M. Lartet in his letter 'made some statements in regard to the disposition of the bones in the digits of the huge edentate the remains of which had been found at Sansan, but these remarks, which are designed to correct an opinion previously expressed by the author, would be difficult to understand without the figure, which M. Lartet has transmitted with his letter.' This figure is not published in the *Comptes Rendus*.

De Blainville, Henri Marie Ducrotay.—"*Rapport sur un nouvel envoi de fossiles provenant du dépôt de Sansan.*" Par M. de Blainville. Comptes Rendus des Séances de l'Académie des Sciences, 1837, Vol. V, pp. 417–427.

The report presented by M. de Blainville related to the sending of fossils made by M. Lartet and his letter of which acknowledgment was made at the session of August 7th.

On page 418 M. de Blainville remarks: "In the first place he (M. Lartet) rectifies with a frankness as loyal as explicit an error, which in view of his isolated position is perfectly excusable. The mistake he made occurred when speaking of the mode of locomotion of the singular and gigantic animal belonging to the edentates, of which he had only found a single tooth and some phalanges at the time of his first shipment of specimens. To this animal he has felt justified since that time in applying the name *Macrotherium*, which we very willingly shall adopt. The method of locomotion which M. Lartet now proposes in the case of this animal is much more in accordance with analogies and is probably correct." (Trans. W. J. H.)

On page 424 M. de Blainville says: "Of the greatest interest are some new fragments of the gigantic *Macrotherium*, showing plainly that the digits possessed an organization very analogous to the same parts in the *Orycteropus*, a living edentate, confined to the southern extremity of Africa." (Trans. W. J. H.)

FALCONER, HUGH, AND CAUTLEY, P. T.—Transactions of the Geological Society of London, Vol. V, p. 502.

The authors give a description of *Anoplotherium sivalense* based upon fragments in their possession.

1839–1864.

DE BLAINVILLE, H. M. D.—"*Osteographie*" Anoplotheriums, p. 66, Planches III and IV.

The plates represent with fidelity the remains of the "grande Anoplotherium" of Lartet = *Macrotherium grande*.

1847.

FALCONER, HUGH, AND CAUTLEY, P. T.—"*Fauna Antiqua Sivalensis*" Folio, Plates only.

In Part VIII, Plate 80, nine figures are given, showing the dentition and the anterior portion of the skull of *Chalicotherium sivalense*. Fig. 1*b* seems to show an opening, which, unless we had the paper published in 1868 (*cf.* H. Falconer under that date), would certainly lead the student to believe that there existed a vacant alveolus for an incisor in the lower jaw.

1848–1852.[2]

GERVAIS, PAUL—"*Zoölogie et Paléontologie Francaises*," Vol. I, p. 91.

Gervais applies to the "grand Anoplotherium" of Lartet, which the latter found at the same place where he had discovered the remains of the "Pangolin gigantesque," the generic name proposed by Kaup in 1833, the generic identity of the forms being shown by the dentition. *Chalicotherium grande* (Gervais) Lartet, thenceforth, is recognized as a Perissodactyl, through the remains of the head; while the feet are still regarded as representing the remains of a colossal edentate, *Macrotherium*.

1853.

PICTET, FRANÇOIS JULES—"*Traité Elémentaire de Paléontologie*" (Second Edition),[3] Tome I, p. 337; Atlas Pl. XV, fig. 6.

Under *Chalicotherium* Kaup, Pictet in the figure above cited gives figures of a detached molar tooth and of four united molars.

In the text he recognizes four species of *Chalicotherium* as having been ascertained to have existed, the two named by Kaup, of which Pictet says that "C. Goldfussi had the size of the Javan rhinoceros," while he compares the smaller species with "the Sumatran rhinoceros"; *C. grande* Gervais; and *C. sivalense* Falconer & Cautley, the latter figured, but not as yet described.

1854.

ROTH (JOHANNES) AND WAGNER (JOHANN ANDREAS)—Abhandlungen der Bayerischen Akademie der Wissenschaften, Vol. VII, p. 415, Pl. X, figs. 1 and 2.

The authors describe and figure the proximal phalanx of an undetermined species of *Macrotherium* from Pikermi.

[2] A second edition was published in 1859.

[3] The first edition was published in 1844.

1856.

GAUDRY ET LARTET—Comptes Rendus, Vol. XLIII p. 271.

Give a description of *Macrotherium.*

1857.

WAGNER, JOHANN ANDREAS—"*Neue Beiträge zur Kenntniss der fossilen Säugthier-Ueberreste von Pikermi.*" Abhandl. d. K. Bayer. Akademie d. Wissenschaften, II Cl., Bd. VIII, Abth. 1.

Describes and figures the superior dentition of an animal from Pikermi, which he associates with his *Rhinoceros pachygnathus* from the same locality.

KAUP, J. J.—"*Beiträge zur näheren Kenntniss der urweltlichen Säugethiere.*" 4tes Heft.

The author sets up the genus *Nestoritherium* for the reception of the Chalicotheroid from Pikermi, originally described and figured by Wagner in 1857 as being a portion of his *Rhinoceros pachygnathus.*

1862–1867.

GAUDRY, ALBERT—"*Animaux Fossiles et Géologie de l'Attique.*"

A most important work, in which the author fully describes and figures the chalicotherine remains found by him and his associates at Pikermi, during their explorations made in 1855–56, and in which he erects the genus *Ancylotherium* for these remains.

1868.

FALCONER, HUGH—"*Fauna Antiqua Sivalensis,*" 8vo, pp. l–lvi + 1–590, Pl. I–XXXIV. Being Vol. I of the "*Palæontological memoirs and notes of the late Hugh Falconer,*" etc., edited by Charles Murchison.

On pp. 208–226 there is given a full account of the remains of *Chalicotherium sivalense,* the paper having been prepared in 1847 for the Geological Society, but not presented, and being for the first time published in 1868. It is accompanied by thirty-four plates, which are taken from the large folio plates of the *Fauna Antiqua Sivalensis* and reduced to octavo size. Of these, Plate 17 (corresponding to Plate 80 of the great folio, with the omission of Figs. 1*c* and 3*a* of the latter) curiously enough in figs. 3 and 4 appears to indicate the presence of an incisor tooth in the upper jaw, though the author explicitly states that no incisor is present, and fig. 5 appears to show a vacant alveolus for an incisor in the lower jaw, though here also the author emphatically denies the existence of any trace of incisors in this fragment.

MURCHISON, CHARLES—"*Description of the Plates of the Fauna Antiqua Sivalensis Compiled from Notes and Memoranda by Hugh Falconer, M.D.*" Issued as a reprint of pp. 421–556 of the work last cited, with a new pagination, page 421 being page 1, etc.

On p. 103 we find the following: "Figs. 1, 1*a*, 1*b*, and 1*c*.—Anterior half of an adult head, with the upper and lower jaws in natural apposition, and exhibiting the greatest portion of the dental series of both jaws. The greater part of the cranium is absent.

The specimen demonstrates the very remarkable fact that the *Chalicotherium sivalense* was entirely destitute of incisor teeth in either jaw. The intermaxillary bones are perfect to their tips, and consist of slender slips of bone converging to a sharp point; they show that no incisor teeth could have existed in the upper jaw at any period of the animal's age. The anterior portion of the lower jaw is perfect to the alveolar edge. A detached canine is seen on either side, but the intervening space is without a vestige of incisors, and is contracted in correspondence with the convergence of the intermaxillary bones, and sloped off to a fine edge. The upper jaw is also destitute of canines or of any trace of canine alveoli; but the lower jaw contains two canines, as shown in figs. 1*a* and 1*b*, the crowns of which are thick, cuneiform, and somewhat triangular, and slightly inclined forward, with a blunt apex. The specimen shows three premolars and the first true molar; the two back molars are absent. The characters of the molars are better seen in figs. 3 and 4, and are described in great detail in Dr. F.'s Memoir on *Chalicotherium*."

"This beautiful specimen was originally in the Dadoopoor Collection of Messrs. Baker and Durand, and is now in the Museum of Marischal College, Aberdeen, Cast in British Museum."

1870.

Owen, Richard—"*On Fossil Remains of Mammals found in China.*" Quarterly Journal of the Geological Society, Vol. XXVI, pp. 417–434.

On pp. 429–433 the author describes the last right upper molar of a species, to which he gives the name of *Chalicotherium sinense*. On Plate XXIX, figs. 7–10, he gives views of this tooth. The specimen was "obtained in a cave" by Robert Swinhoe, Esqr.

Huxley, Thomas H.—"*Anniversary Address of the President of the Geological Society.*" Quarterly Journal of the Geological Society of London, Vol. XXVI, pp. xlii–lxiv.

On p. lvii the name *Homalodotherium* is announced for "a new Anoplotherioid mammal, which Dr. Cunningham sent over to me some time ago from Patagonia."

1872.

Gill, Theodore N.—"*Arrangement of the Families of Mammals, and Synoptic Tables of Characters of the Subdivisions of Mammals.*" Smithsonian Miscellaneous Collections, No. 230.

Dr. Gill in this paper locates the Chalicotheriidæ among the Artiodactyla. On p. 71 he characterizes them as follows:

"Incisors deciduous from upper as well as lower jaws. Canines of lower jaw inclined forwards, with compressed cuneate crowns. Placenta and stomach unknown."

On p. 76 he erects the superfamily *Chalicotheroidea*.

1873.

GAUDRY, ALBERT—"*Animaux Fossiles du Mont Leberon.*"

On p. 84 the author lists *Chalicotherium* from Eppelsheim among the Pachyderms, and on pp. 88 and 91 points out the relationship between *Macrotherium* and his *Ancylotherium.*

KOWALEVSKY, WOLDEMAR—"*Monographie der Gattung Anthracotherium Cuv. und Versuch einer Natürlichen Classification der fossilen Hufthiere.*" Palæontographica, Vol. XXII, pp. 131–346.

Kowalevsky says, p. 175: "Of *Chalicotherium* (*Anisodon*), which is often represented as a descendant of *Anoplotherium*, we know but little, more particularly are we left in ignorance of its skeletal structure. If it belongs to the Artiodactyla it evidently represents a line of descent older than *Anoplotherium*, that is standing nearer the point at which the Artiodactyla and the Perissodactyla separated from each other, for the reason that the molars of the lower jaw are almost entirely like those of the Perissodactyla without any trace of the folding of the inner cusps, which is to be already detected in the *Anoplotheria*. *Anisodon* retains the canines. The transition from the upper molars to the premolars through the short P^1 is not sudden, but the premolars of *Anisodon* reveal a gradual simplification of the molars such as is to be observed almost exclusively in the Perissodactyla. *Anisodon* appears to have no connection with the existing fauna, and it is even doubtful whether it should be assigned to the Artiodactyla, since the astragali from Sansan which have been attributed to it, perhaps do not belong to it at all."

On pp. 248–251 the author from an examination of the milk dentition of *Chalicotherium* concludes that it cannot belong to the Artiodactyla, but should be referred to the Perissodactyla.

FLOWER, WILLIAM H.—Proceedings of the Royal Society of London, Vol. XXI, p. 383.

Dr. Flower erects the genus *Homalotherium* for the remains received by Huxley, and to which the latter alluded in his Annual Address before the Geological Society of London in 1870. (*Cf.* Quarterly Journal Geol. Society, Vol. XXVI, p. lvii.)

1874.

COPE, E. D.—"*Report upon Vertebrate Fossils Discovered in New Mexico, with Descriptions of New Species.*" Annual Report of the Chief Engineers, 1874. Appendix FF. 3, pp. 591–606. Issued as a separate reprint from the Government Printing Office, Nov. 28, 1874, pp. 1–18.

The original description of *Meniscotherium chamense* gen. et sp. nov. Cope, is given on p. 596, as follows:

"*Char. gen.*—Molars three, with two continuous external crescents and two internal tubercles, except on the posterior, where there is but one, the anterior conic tubercle. The posterior tubercles on the other molars crescentoid in section. A well-developed

crescent between the anterior tubercle and anterior crescent, and an oblique crest extending from the latter to the adjacent horn of the posterior inner tubercle. Two external crescents on the last premolar.

" This genus presents a curious combination in the structure of its molars of the character of *Palæosyops, Hyopotamus,* and *Hipposyus.* It is exceptional among the ungulates of the same fauna in the number of crescents of the molars.

" *Char. Specif.* Last molar with the oblique inner posterior crest terminating at the posterior margin of the crown. Prominant external ribs at the point of connection of the external crescents of the crown. No cingula; enamel entirely smooth.

MEASUREMENTS.

	M.
"Length (externally) of last four molars	.029
Length of true molars	.022
Length of penultimate molar	.009
Width of penultimate molar	.010

" This animal was about the size of the racoon, and probably had the habits of the tapirs."

FLOWER, WILLIAM H.—(Philosophical Transactions, Vol. CLXIV, p. 173.)

Homalodontotherium cunninghami is described.

MARSH, O. C.—" *On the Structure and Affinities of the Brontotheriidæ.*" Amer. Journal of Science (3), Vol. VII, p. 82.

The author states that the molars of the Brontotheriidæ resemble those of *Chalicotherium.*

1875.

COPE, E. D.—" *Geographical Explorations and Survey West of the 100th Meridian, Systematic Catalogue of Vertebrata of the Eocene of New Mexico Collected in 1874.*"

P. 19. *Meniscotherium chamense* Cope, cited under the Perissodactyla.

GAUDRY, A.—" *Sur de nouvelles pièces fossiles découvertes dans les phosphorites du Quercy.*" Comptes Rendus, Vol. LXXXI, p. 1113.

Contains an account of the discovery at Bach in the canton of Lalbenque of the upper jaws of a *Chalicotherium* three-fourths the size of that of *Chalicotherium magnum,* revealing minor differences in the dentition. To this form he applies the specific name *modicum,* to indicate that the oldest representatives of the genus *Chalicotherium,* were smaller than their successors of the middle Miocene, which in turn were smaller than their successors represented by *Chalicotherium goldfussi,* of the upper Miocene. He also calls attention to the fact that the teeth of *Chalicotherium* and the other genera associated with it show that they were given to feeding upon grasses, and that therefore in the south of France before the middle of the Miocene epoch there must have been a considerable development of meadow-lands.

GAUDRY, A.—"*Sur quelques indices de l'existence d'Édentés de l'Époque Miocène.*" Comptes Rendus, Vol. LXXXI, pp. 1036–1038.

"The phosphorites of the neighborhood of Caylus, in which MM. Gervais, Filhol, and Delfortrie have already discovered fossils of many various types, have recently furnished proofs of the existence of an animal, which evidently belonged to the order of Edentates. Representatives of this order have not yet been observed in any formation as old as this.

The determination of the Edentate from the phosphorites is based upon only two fragments, but these two fragments are very characteristic. They are a first phalanx and an ungual phalanx, which appear to belong to the same digit. The first phalanx is 3.5 cm. long; its metatarsal articulating surface lies obliquely in such a way that the digit could be raised toward the metatarsal. The articulating surface corresponding to the second phalanx is likewise oblique. The ungual phalanx is 2.4 cm. in length by 1.3 cm. in width. The surface by which it articulates with the second phalanx is prolonged a little in its upper portion and thus indicates that there was less play for extension than for flexion. The ungual phalanx had in front a deep median fissure through which, without doubt, as in the Pangolins, there passed a corneous cushion uniting the upper surface of the claw to its lower surface, whence we may conclude that the claws were large and solid. Although the claw was hooked, the animal would not have been incommoded in its gait because of the power which the first phalanx had to throw itself back upon the metatarsal.

Typotherium and certain Ungulates (notably *Paloplotherium minus*) have a fissure on their ungual phalanges, but the form and manner of union of the phalanges are entirely different from what is seen in the specimen from the phosphorites. The Edentates of the genus *Pangolin*, which have a cloven phalanx, can only to a small degree retract their first phalanges toward the metacarpals and metatarsals. In the case of the sloths the first phalanx articulates by a ginglymus with the metacarpals and the metatarsals, even coalescing with them. In the case of *Orycteropus* and the armadillos the digits are not hooked. The ant-eaters and the fossil Gravigradentia of America have digits allowing a very great degree of flexion, but the first phalanges are scarcely able to draw back toward the metacarpals and metatarsals.

It is only in the little group of fossil Edentates from Europe for which Professor Gervais has suggested the name of the *Macrotheriidæ* that there is seen a disposition of the digits analogous to that presented by these specimens which I am calling to the attention of the Academy. The *Macrotheriidæ* include the genera *Macrotherium* and *Ancylotherium*. I provisionally assign the Edentate from the phosphorites to the latter genus, giving it the name *priscum* to distinguish it from *Ancylotherium Pentelici*. The phalanges of *Ancylotherium priscum* display notable differences from the fore feet of the species from Pikermi. They have points of resemblance with the feet of the latter species, nevertheless they are easy to distinguish. They are not one-fourth of

the size of the smallest phalanges of *Ancylotherium Pentelici*. The latter was a gigantic animal probably greatly exceeding in size the largest rhinoceros, while the foot of the Edentate from the phosphorites hardly equaled in size that of a pig. Judging by the form of the upper surface of the ungual phalanx the articulation of this phalanx with the second was not as solid as in the case of *Ancylotherium Pentelici* and *Macrotherium;* it permitted a measure of lateral movement, while in the other species only backward and forward movement was allowed. The posterior surface of the ungual phalanx of *Ancylotherium priscum* was less curved above than in *Ancylotherium Pentelici*, and much less than in *Macrotherium*. We may hence conclude that the digit was very hooked in the *Macrotherium*, a little less hooked in *Ancylotherium Pentelici*, and still less hooked in *Ancylotherium priscum*. Thus we are led to conclude that the older form was less specialized and not so greatly separated from that of other Ungulates. The fragments of *Ancylotherium priscum* collected at Mouillac, canton of Caylus (Tarn-et-Garonne) by Mons. Rossignol, have been presented to the Museum. M. Rossignol has also sent me fragments excavated in the same place, which are referable to the following species: *Œlurogale intermedia, Cynodictis compressidens*, a smaller *Cynodictis, Canis palœolycos, Hyœnodon leptorhynchus*, a carnivore, related to *Pseudælurus Edwardsi, Amphictis ambigua, Lophiomeryx, Dichobune, Cainotherium, Gelocus*. There is therefore reason to believe that the Edentate of the phosphorites lived, it may be, in the epoch of the Lower Miocene (horizon of the Fontainebleau sands), it may be in the last phase of the Eocene (horizon of the Brie limestone).

In the neighborhood of Cantayrac, which, like Mouillac, belongs to the canton of Caylus, M. Rossignol has discovered another ungual phalanx, the fissure of which recalls *Ancylotherium*, but this phalanx is much smaller yet than that of *Ancylotherium priscum*. It is also more compressed latterly. Its length is 11 mm., its breadth in the middle only 5 mm. It is bulged on its lower surface, showing that it rested flat upon the ground. Its upper surface, intended to be connected with the second phalanx, is surrounded by a rim or flange which does not exist in *Ancylotherium*. Besides it is almost flat and straight. This shows that the digit to which it belonged was not hooked. It is possible that this fragment did not belong to an Edentate." (Trans. W. J. H.)

GAUDRY, A.—"*Sur quelques Pièces de Mammifères Fossiles qui ont été trouvés dans les Phosphorites du Quercy.*" Journal de Zoölogie, Vol. IV, pp. 518–527.

The article is an elaboration of the two communications made to the Academy of Sciences and published in the *Comptes Rendus*, Vol. LXXXI, at p. 1036 and p. 1113. It is accompanied by Plate XVIII, in which figs. 3–8 represent the type of *Chalicotherium priscum*, and figs. 13–14 represent the type of *Chalicotherium modicum*.

1876.

GERVAIS, PAUL—Journa lde Zoölogie, Vol. V, pp. 424–432, Pl. XVIII.

The genus *Pernatherium* (type *P. rugosum*) from the Eocene of Paris is established. It differs from *Macrotherium* and *Ancylotherium* in the form of the os calcaneum.

—— —— "*Zoölogie et Paléontologie Generales*," Second Series.

At p. 59 Gervais remarks upon *Ancylotherium pentelici* Gaudry and *Schizotherium priscum* Gaudry.

1877.

Filhol, H.—"*Recherches sur les Phosphorites du Quercy, Étude des Fossiles qu'on y Rencontre, et spécialement des Mammifères.*" Annales des Sciences Géologiques, Tome VIII, pp. 1–340, Pl. I–XXVIII.

On pp. 273–275 the author discusses *Ancylotherium priscum* Gaudry, which is recognized as belonging to the Edentata, family *Macrotheriidæ*. Speaking of the analogies between the species found in the phosphorites of Quercy, *A. priscum*, and the species found at Pikermi, *A. pentelici*, he quotes from Gaudry, Journal de Zoölogie, Vol. IV, pp. 518–520.

The author gives an account of *Chalicotherium modicum* Gaudry, and quotes the original description. He states that the "slight differences" upon which the species was founded by M. Gaudry, appear to him scarcely to possess specific value. Fig. 343 is a representation of the type already figured by M. Gaudry.

Gaudry, Albert—"*Letter to Count Saporta on North American Vertebrate Paleontology.*" American Naturalist, Vol. XI, pp. 184–186.

Gervais, Paul—"*Remarques Ostéologiques au Sujet des Pieds des Édentés.*" Journal de Zoölogie, Tome VI, pp. 79–82, 198–228, Pls. II–IV.

On pp. 221–226, and on Pl. II, the author sets forth his views as to the structure of the foot of *Ancylotherium pentelici* and *Macrotherium giganteum*. He announces that he has critically reëxamined the specimens and gives figures illustrating the attempt which he has made to reconstruct the feet.

Marsh, O. C.—"*Note of Some New Vertebrate Fossils.*" American Journal of Science and Art (3), Vol. XIV, Sept., 1877, pp. 249–256.

The author describes the genus *Moropus* and erects three species, *distans*, *senex*, and *elatus*, the two former from the John Day Miocene, and the latter from the lower Miocene of Nebraska. Marsh compared his specimens with the European Macrotheres and, following the example of European authors, placed the genus in the Edentata.

—— —— "*Introduction and Succession of Vertebrate Life in America. An Address delivered before the American Association for the Advancement of Science, at Nashville, Tenn., Aug. 30, 1877.*"

At p. 24 we find the following: "The edentate mammals are evidently an American type, and on this continent attained a great development in numbers and size. No Eocene edentates have been found here, and, although their discovery in this formation has been announced, the identification proves to have been erroneous. In the Miocene of the Pacific Coast a few fossils have been discovered, which belong to this group, and to the genus *Moropus*. There are two species, one about as large as a tapir, and another

nearly twice that size. This genus is the type of a distinct family, the *Moropodidæ*. In the Lower Pliocene above, well-preserved remains of edentates of very large size have been found at several widely separated localities in Idaho and California. These belong to the genus *Morotherium*, of which two species are known. East of the Rocky Mountains, in the Lower Pliocene of Nebraska, a large species, apparently of the genus *Moropus*, has been discovered. The horizon of these later fossils corresponds nearly with beds in Europe that have been called Miocene. In the Post-pliocene of North America gigantic edentates were very numerous and widely distributed, but all disappeared with the close of that period. These forms were essentially huge sloths, and the more important genera were *Megatherium*, *Mylodon*, and *Megalonyx*. The genera *Megalocnus* and *Myomorphus* have been found only in Cuba."

1878.

GAUDRY, ALBERT—"*Les Enchaînements du Monde Animal dans les Temps Géologiques. Mammifères Tertiaires.*"

On pp. 192–198 the author discusses under the Edentates the feet of *Macrotherium* and *Ancylotherium*, and gives numerous figures in the text.

KING, CLARENCE—*U. S. Geological Exploration 40th Parallel. Systematic Geology, Vol. I.*

On p. 424 *Moropus distans* and *senex* Marsh are listed from the John Day Beds; on p. 430 *Moropus elatus* Marsh is listed from the Loup Fork Beds.

1879.

COPE, E. D.—Proceedings American Philosophical Society, Vol. XVIII, p. 77.

Dœodon shoshoniensis is described as the type of a new genus and species of Chalicotheres from the Miocene of Oregon. The author states that it is allied to *Menodus* and *Symborodon*. (*Dœodon* is an entelodont. *Cf.* Peterson, Memoirs Carnegie Museum, Vol. IV, p. 63.)

1880.

FILHOL, H.—*Limognitherium ingens* gen. et sp. nov. Comptes Rendus, Vol. XC, p. 1580.

"Édentés.—L'étude de quelques métacarpiens trouvés à Limogne m'a permis de découvrir l'existence ancienne d'un nouveau genre d'édenté. L'animal dont proviennent les os qui m'ont été remis avait une taille puissante, car son troisième métacarpien mesure 0.180 de longueur. La forme des extremités articulaires inférieures est semblable à celles des extrémités inférieures des métacarpiens du *Macrotherium giganteum*, mais les surfaces carpiennes sont absolument differentes. Le premier doigt paraît ne pas avoir existé. Le troisième métacarpien s'articulait avec le grand os et peutêtre avec le trapézoïde."

"Je nommerai le genre nouveau dont proviennent les pièces que je viens de signaler *Limognitherium*," etc., etc.

——— ——— *Ancylotherium gaudrii* sp. nov. Bulletin Soc. Philom. (7), iii, p. 125.

Filhol dedicates to Mons. Gaudry a supposedly new species of *Ancylotherium* from the Phosphorite beds of Quercy.

Cope, E. D.—"*On the Extinct Species of Rhinoceridæ of North America and their Allies.*" Bulletin of the U. S. Geol. and Geog. Survey of the Territories, Hayden, Vol. V, 1878, pp. 227–237.

In the analytical table on p. 228 the *Chalicotheriidæ* are differentiated from the *Palæotheriidæ* by having tubercles on the inner part of the crown of the superior molars, while the latter have cross-crests.

Lydekker, Richard—"*Molar Teeth and Other Remains of Mammalia.*" Memoirs of the Geological Survey of India, Series X, 2, p. 64, Pl. VIII, figs. 11 and 14.

The author describes and figures the second phalanx of a Chalicothere under the name of *Manis sindiensis.*

1881.

Cope, E. D.—"*Note upon the proposed Classification of the Perissodactyla, to be given by the author in the forthcoming Report of the U. S. Agricultural Survey of the Territories of Dr. Hayden.*"

American Naturalist, Vol. XIV, p. 197. *Lambdotherium brownianum* is described from Wasatch of Wyoming and referred to the Chalicotheres.

American Naturalist, Vol. XIV, p. 383. Description of *Triplopus cubitalis* gen. et sp. nov. from Washakie Beds (Eocene); and *l. c.*, p. 389 *Triplopus amarorum* sp. nov. from same formation.

American Naturalist, Vol. XIV, p. 747. Description of *Hyracotherium vortmani* and *H. craspedotum* spp. nov. from Wasatch of Wyoming, referred to the Chalicotheriidæ.

Bull. U. S. Geol. Survey, Vol. VI, p. 198. Description of *Hyracotherium venticolum* from Wasatch of Wyoming.

Bull. U. S. Geol. Survey, Vol. VI, p. 199. *H. venticolum* is referred to *Phenacodus.*

American Naturalist, Vol. XIV, p. 746. Description of *Lambdotherium popoagicum* from Wasatch of Wyoming, referred to the Chalicotheriidæ.

Proceedings American Philosophical Society, Vol. XX, p. 182. Description of *Oligotomus Osbornianus* sp. n. from Lower Eocene of Wyoming, referrred to the Chalicotheres.

American Naturalist, Vol. XV, p. 1018. Genus *Systemodon* erected to receive "*Hyracotherium*" *tapirinum.*

Proceedings American Philosophical Society, Vol. XX, p. 184. Description of *Systemodon semihians* sp. nov. from Lower Eocene of Wyoming.

[*Note.* All the species referred in the foregoing papers by Cope to the Chalicotheriidæ have since been transferrred to other families.—W. J. H.]

1881.

COPE, E. D.—"*The Systematic Arrangement of the Order Perissodactyla.*" Proceedings of the American Philosophical Society, Vol. XIX, pp. 377–403.

On p. 395 the Chalicotheriidæ are given a place between the Tapiridæ and the Menodontidæ, and the following genera are indicated as belonging to the group:

Europe—*Rhagatherium, Propalæotherium, Chalicotherium.*

N. America—*Leurocephalus, Palæosyops, Limnohyus, Lambdotherium, Meniscotherium.*

Asia—*Nestoritherium.*

——— "*The Classification of the Perissodactyla.*" American Naturalist, Vol. XV, p. 340.

Practically the same paper as the foregoing.

1882.

COPE, E. D.—"*Synopsis of the Vertebrata of the Puerco Eocene Epoch.*" Proceedings of the American Philosophical Society, Vol. XX, pp. 461–471.

On p. 470 the author describes *Meniscotherium tapiacitis* sp. nov.

——— American Naturalist, Vol. XVI, p. 522. The genus *Ectocion* is established for the reception of *Oligotomus osbornianus.* "If it is not condylarthrous, it must be placed in the Chalicotheriidæ as the most primitive form." (*Note.* Since recognized as belonging to the Phenacodontidæ.—W. J. H.)

1883.

COPE, E. D.—Proceedings of the American Philosophical Society, Vol. XX, p. 443. Manus of *Hyracotherium venticolum* figured. (*Note.* Now referred to the *Equidæ.*—W. J. H.)

SCHLOSSER, MAX—Jahrbuch der Mineralogie, 1883, ii, p. 164.

The genus *Hyracotherium* is discussed.

1884.

MARSH, O. C.—"*Dinocerata, a Monograph of an Extinct Order of Gigantic Mammals.*"

On p. 172 Professor Marsh suggests the descent of *Chalicotherium* from *Diplacodon* through *Brontotherium.*

PETHŐ, J.—"*Ueber die Fossilen Säugethier-überreste von Baltavár.*" Jahrbuch d. K. Ungar. Geol. Anstalt, 1884, pp. 455–464.

Describes *Chalicotherium baltavarense.*

1885.

COPE, E. D.—"*The Vertebrata of the Tertiary Formations of the West. Book I.*" Report of the U. S. Geological Survey of the Territories by F. V. Hayden, Geologist in charge. Vol. III, Washington, pp. xxxv+1009, Pls. I–LXXV*a*.

On p. 32 Cope speaks of *Macrotherium* as an Edentate; on p. 33 he states that the remains of Chalicotheres have been found in the White River Beds; on p. 34 he gives the horizon of the European Chalicotheres as Tongrian, and on p. 694 he classifies the Chalicotheres and gives a table of characters for them.

1886.

Lydekker, Richard—"*Catalogue of Fossil Mammalia in the British Museum,*" Part III, Chalicotheriidæ, pp. 161–165.

Dr. Lydekker includes all the Old-World forms under the genus *Chalicotherium* and sinks *Anisodon* Lartet and *Nestoritherium* Kaup as synonyms.

P. 160. *Homalodontotherium* Huxley is briefly characterized from the dentition.

—— —— "*Indian Tertiary and Post-tertiary Vertebrata. Part II. The Fauna of the Karnul Caves.*" Memoirs of the Geological Survey of India, Vol. IV, p. 50.

The author corrects the reference to the genus *Manis* of the species described by him in 1880, and names it *Macrotherium sindiense.*

Schlosser, Max—Zoölogischer Anzeiger, Vol. IX, p. 253.

"The Chalicotheriidæ possibly begin with *Ectocion* Cope, one of the Condylarthra from which *Meniscotherium* and *Hyracodontherium* branch off as a Condylarthrous side-branch. The Chalicotheres themselves are derived from *Lambdotherium.* This had its origin from a form which may also be regarded as the ancestor of *Limnohyus* and *Palæosyops.* From *Palæosyops* arise in succession *Diplacodon, Titanotherium,* and *Leptodon.*"

—— —— "*Beiträge zur Kenntniss der Stammes-geschichte der Hufthiere und Versuch einer Systematik der Paar- und Unpaarhufer.*" Morphologisches Jahrbuch, Vol. XII, pp. 1–136, Pls. I–VI.

(An abstract of this paper is given in the Archiv für Anthropologie, Vol. XVIII, pp. 131–139.)

1887.

Cope, E. D.—"The Perissodactyla." American Naturalist, Vol. XXI, pp. 985–1007 and 1060–1076.

In the "genealogical tree" proposed by the author he represents a line of descent from the *Hyracotheriinæ,* running in succession through the following families: Chalicotheriidæ, Menodontidæ, Palæotheriidæ, to the Equidæ.

The Chalicotheriidæ according to Cope are related on the one hand to the *Lophiodontidæ* and on the other to the *Menodontidæ.* Cope divides the genera which he regards as allied into two categories:—I, those in which the interior cones of the superior molars are separate from the external lobes: *Ectocion* Cope, *Epihippus* Marsh, *Leurocephalus* S. & O., *Palæosyops* Leidy, *Limnohyus* Leidy, *Lambdotherium* Cope, *Nestoritherium* Kaup; and, II, in which one or both interior cusps of the superior

molars are united with the external lobes by cross-crests: *Pachynolophus* Pomel, and *Chalicotherium* Kaup.

Cope properly gives warning that the foot-structure of some of these genera is unknown, and that therefore there may be doubt as to the correctness of the proposed classification.

1888.

Osborn, H. F.—"*Chalicotherium and Macrotherium.*" American Naturalist, Vol. XXII, pp. 728–729.

Dr. Osborn calls attention in a brief note to the fact that M. Henri Filhol has made the remarkable discovery at Sansan that *Chalicotherium* and *Macrotherium* are identical, and points out that *Chalicotherium* represents an aberrant form of the Perissodactyla,

Rütimeyer, L.—Abhandlungen der Schweizerischen Paläontologischen Gesellschaft, Vol. XV, pp. 50–52.

Meniscodon. The writer discusses a tooth found at Egerkingen, which he compares with that of *Meniscotherium* Cope from the Wasatch.

1889.

Cope, E. D.—"*The Vertebrata of the Swift Current River, II.*" American Naturalist, XXIII, pp. 151–155.

In this brief paper Cope describes the mandibular symphysis and a part of the left ramus of an adult animal to which he applies the name *Chalicotherium bilobatum.* He then says:

"Although this is the first announcement of the discovery of the genus *Chalicotherium* in America, it is not the first discovery. Professor Scott showed me a series of superior molars from the Loup Fork formation of Kansas, from the Agassiz Museum, which he identified as belonging to this genus. The present species is of larger size than the Kansas form and is apparently equal to the *C. goldfussi* of the Upper Miocene of Europe. The occurrence of this form in the Lower Miocene (White River), as well as the Upper Miocene (Loup Fork) of this country, is a noteworthy fact, but is parallel to its history in Europe. Described from the Upper Miocene by Kaup, it was afterwards found in the Middle Miocene (*C. grande*) by Lartet, and in the Upper Eocene (*C. modicum*), by Gaudry.

The remarkable character of this genus, as discovered by Filhol, has already been mentioned in the *Naturalist.*[4] It has little relation to the family of Perissodactyla to which it has given the name, and which it so resembles in molar dentition. It must form a family by itself, and the genera with which it has been associated must form a family to which the name Lambdotheriidæ may be applied. The anterior ungual phalanges of *Chalicotherium* are of prehensile character and not ungulate, but rather unguiculate. The phalanges resemble those of the Edentata, but the carpus and tarsus are,

[4] Osborn on *Chalicotherium* and *Macrotherium,* 1888, p. 728.

according to Filhol, diplarthrous in structure, while the Edentata are taxeopodous. We have in the Chalicotheriidæ the antithesis of the Condylarthra. While the latter is ungulate with an unguiculate carpus and tarsus, the former is unguiculate with an ungulate (diplarthrous) carpus and tarsus. Thus the Chalicotheriidæ must be referred to a distinct order of unguiculate mammalia, which I propose to call the Ancylopoda, with the above definition. Two genera belong to the single family, the Chalicotheriidæ, viz., *Chalicotherium* Kaup, and *Ancylotherium* Gaudry. In the former, the phalanges are distinct; in the latter the first and second are coössified (Lydekker). Marsh did not show how his genus *Moropus* differs from *Ancylotherium*. The species described by Marsh under this name are from the Loup Fork bed of Kansas."

——— "The Edentata of North America." American Naturalist, Vol. XXIII, pp. 657–664.

Pouchet, G., et Beauregard, H.—"*Traité d'Ostéologie Comparée.*"

On p. 204 the writers say: "Le passage entre les Lophiodontes et les Palæotherium est établi par les *Chalicotherides*, qui, tout en possédant les mêmes caractères digitaux, ont une dentition plus equine; en effet les deux tubercules externes sont séparés par un sillon vertical et les molaires inférieures établissent le passage entre le type quadricuspide des genres anciens et la forme à double croissant des Palæotherium et des chevaux actuels."

1890.

Filhol, H.—"*Etudes sur les Mammifères Fossiles de Sansan.*" Bibliothéque de l'École, des Hautes Études. Section des Sciences Naturelles, Tome XXXVII, pp. 1–319, Pl. I–XLVI.

On pp. 294–305, the author gives an account of *Chalicotherium magnum* Lartet, of which he regards *Macrotherium sansaniense* Lartet as a synonym, and devotes Plate XLIII to the restoration of the animal and Plates XLIV–XLVI to drawings of portions of the skull and feet. The evidence for the identity of the two genera hitherto regarded as distinct is given in detail.

Scott and Osborn—"*Preliminary Account of the Fossil Mammals from the White River and Loup Fork Formations Contained in the Museum of Comparative Zoology.*" Bulletin of the Museum of Comparative Zoology, Vol. XX, No. 3, 1890, pp. 65–100.

(The Perissodactyla were described by H. F. Osborn.) On p. 99 *Moropus* Marsh is treated as a synonym of *Chalicotherium* Kaup. A fragment of a right superior maxillary, doubtfully referred to *Chalicotherium elatum* Marsh, is described and figured.

Steinman (Gustav) and Döderlein (Ludwig)—"*Elemente der Paleontologie,*" pp. xix+848, 1030 figures in the text.

At p. 776 there is a brief account of the Chalicotheres.

1891.

AMEGHINO, FLORENTINO—"*Determinación de algunos jalones para la Restauración de las antiguas conexiones del Continente Sud Americano.*" Revista Argentina de Historia Natural, Vol. I, pp. 282–288.

COPE, E. D.—"*On Vertebrata from the Tertiary and Cretaceous Rocks of the Northwest Territory. I. The Species from the Oligocene or Lower Miocene Beds of the Cypress Hills.*" Geological Survey of Canada. Contributions to Canadian Paleontology, Vol. III, pp. 1–25; Pls. I–XIV.

The author redescribes *Chalicotherium bilobatum* Cope.

—— —— "*The Litopterna.*" American Naturalist, Vol. XXV, pp. 687–693, Pl. XVII.

"The teeth of the Astrapotheriidæ (Homalodontotheriidæ) are rhinocerotic, with straight outer walls."

DEPÉRET, CHARLES—Bulletin de la Société Géologique de France (3), Vol. XIX, p. xxx.

This paper contains an announcement of the discovery at Grive-Saint-Alban (Isère) of portions of the limb bones and feet of a skeleton of a huge edentate, closely resembling *Macrotherium sansaniense* Lartet, for which as a local race M. Depéret proposes the name *rhodanicum*. The principal interest of the discovery is stated by M. Depéret to consist in the fact that associated with the remains classified as belonging to *Macrotherium* was a skull belonging to a large *Chalicotherium*, a creature supposed to be related to *Rhinoceros* and *Anoplotherium*, which M. Filhol has been disposed to regard as identical with *Macrotherium* in consequence of his researches at Sansan. M. Depéret points out that the teeth attributed by Gervais to *Macrotherium* (Zoöl. et Pal. Fr., Pl. 43, figs. 1–2) are not those of that animal, but the worn roots of the molars of a mastodon, and that, unless the identification of *Chalicotherium* and *Macrotherium* proposed by Filhol holds, the teeth of *Macrotherium* are unknown.

FILHOL, H.—"*Études sur les Mammifères Fossiles de Sansan.*" Annales des Sciences Géologiques, Tome XXI, pp. 1–319, Pl. I–XLVI.

This is a reprint of the article published in 1890 in the "Bibliotheque de l'École das Hautes Études, Tome XXXVII, the type pagination, and plates being identically the same.

MAJOR, CHARLES IMMANUEL FORSYTH, AND OTHERS—"*Samos. Étude Géologique, Paléontologique, et Botanique.*" Lausanne. 4to. Privately printed.

On pp. 90–94 the author gives an account of the chalicotherine remains found at Mitylini, consisting of superior and milk-dentitions and some foot-bones. The opinions of preceding writers are reviewed.

OSBORN, H. F.—"*Meniscotheriidæ and Chalicotherioidea.*" American Naturalist, Vol. XXV, p. 911.

The author calls attention to the resemblance between the dentition of *Meniscotherium* Cope and *Chalicotherium* Kaup, and suggests the distant relationship of the two genera.

(Noticed by Schlosser in Archiv für Anthropologie, Bd. XXIII, *Appendix*, "Verzeichniss der Anthropologischen Literatur," p. 136.)

Rütimeyer, L.—Abhandlungen der Schweizerischen Paläontologischen Gesellschaft, Vol. XVIII, pp. 10–12.

Meniscodon picteti Rütimeyer.

The author repudiates the identification of *Meniscodon* with *Meniscotherium*, made by Trouessart, Annuaire Geol. Universel, Vol. VI, 1889, p. 683, and gives the specific name *picteti* to that tooth described and figured by him in 1888.

Scott, W. B.—"*The Princeton Scientific Expedition of 1891.*" Princeton College Bulletin, Vol. III, pp. 88–91.

The author announces that remains of *Chalicotherium* occur near Rabbit Creek on the east side of Smith River in Montana.

1892.

Cope, E. D.—"*Professor Marsh on Extinct Horses and Other Mammalia.*" American Naturalist, Vol. XXVI, pp. 410–12.

A critique of Prof. Marsh's paper published in Amer. Journal of Science, 3d Ser., Vol. XLIII, p. 445 *et seq.*

The author claims that the reference of *Meniscotherium* to the Condylarthra made in 1885 is correct, as shown by an examination of the figures of the feet of *Hyracops* Marsh, and repudiates the necessity for the erection of the order *Mesodactyla* proposed by Marsh.

Depéret, Charles—"*La Faune des Mammifères Miocènes de la Grive Saint-Alban (Isère).*" Archives du Museum d'Histoire Naturelle de Lyon. Tome V, pp. 1–95, Pls. I–IV.

A very important and useful paper, in which the Chalicotheres of France are given revisional treatment in the light of the important discoveries as to their osteology made by Filhol and the author.

Earl, C.—"*A Memoir upon the Genus Palæosyops Leidy and its Allies.*" Journal Academy Natural Sciences of Philadelphia, Vol. IX, pp. 267–388, Pls. X–XIV.

On pp. 276 there is a reference to the American Chalicotheres.

Marsh, O. C.—"*A New Order of Extinct Eocene Mammals (Mesodactyla).*" American Journal of Science, 3d Ser., Vol. XLIII, p. 445 *et seq.*

The author, admitting the more or less evident similarity between the dentition of *Meniscotherium* Cope and *Chalicotherium* Kaup, decides from the study of the feet that the former genus and the genus *Hyracops* should constitute a separate order, to which he gives the name *Mesodactyla*. The feet are unlike those of any known ungulates, and "resemble those of Carnivores or the early Primates."

Osborn, H. F.—"*Is Meniscotherium a Member of the Chalicotheriodea?*" American Naturalist, Vol. XXVI, pp. 506–509.

The author states that the publication of the complete foot structure of *Meniscotherium* or *Hyracops* by Marsh tends to confirm the supposition advanced by him in the American Naturalist, Vol. XXV, p. 911, that *Meniscotherium* and the *Chalicotheriodea* are related, and reproduces the figures of the feet of *Hyracops* given by Marsh and of *Chalicotherium* (*Macrotherium*) given by Gervais. Dr. Osborn states that the resemblances between the two forms are "fundamental" and that *Meniscotherium* "will probably be removed from the Condylarthra, where it has always held an anomalous position, and be placed in the Chalicotheriodea."

—— —— "*The Ancestry of Chalicotherium.*" Science, Vol. XIX, p. 276.

1893.

DEAN, BASHFORD—"*Report of a Meeting of the Biological Section of the New York Academy of Sciences held Feb. 13, 1893.*" Anatomischer Anzeiger, VIII, April, 1893, p. 368.

"H. F. Osborn described the foot of *Artionyx*, the new member of the order *Ancylopoda* Cope. It is distinguished from *Chalicotherium* by the character of ankle and pes, which present a marked resemblance to the *Artiodactyla*, while *Chalicotherium* represents these structures as found in Perissodactyla. Both genera are ungulate in ankle-joint, but the phalanges terminate in claws, and in view of the double parallelism between these two forms and the two sub-divisions of Ungulata, it was suggested to divide the *Ancylopoda* into the *Artionychia* and *Perissonychia*."

OSBORN, H. F., AND WORTMAN, J. L.—"*Artionyx, a New Genus of Ancylopoda.*" Bulletin American Museum of Natural History, Vol. V, pp. 1–18.

Artionyx is a synonym of *Agriochœrus* (*cf.* W. B. Scott, 1894).

OSBORN, H. F.—"*The Ancylopoda, Chalicotherium and Artionyx.*" American Naturalist, Vol. XXVII, pp. 118–133.

The author relates the story of the recent discoveries of Filhol and Depéret in France, gives a modified restoration of *Chalicotherium*, following Filhol and Depéret, but representing the feet somewhat more as they are in the Perissodactyla and not plantigrade as represented by the French naturalists. The apparent relationship between *Meniscotherium* and *Chalicotherium* is noted, and attention is called to the discovery of *Artionyx gaudryi* announced in the Bulletin of the American Museum of Natural History for February, 1893, and the subdivision of the Ancylopoda into the suborders *Perissonychia* and *Artionychia* is proposed.

OSBORN, H. F.—"*The Rise of the Mammalia in North America. Address by Henry Fairfield Osborn, Vice-President of the American Association for the Advancement of Science, Section of Zoology, Madison, Wisconsin, Aug. 17, 1893.*" Studies from the Biological Laboratories of Columbia College, Zoölogy, Vol. I, No. 2.

On p. 43 the author accepts the ordinal name *Ancylopoda* proposed by Cope, and briefly reviews the knowledge of the subject at that time possessed. He throws out the suggestion that *Agriochœrus* Leidy, the identity of which with the recently proposed

genus *Artionyx* Osborn & Wortman has been demonstrated by Scott, may be a highly specialized Artiodactyl, and *Chalicotherium* a highly specialized Perissodactyl.

(This paper with certain omissions was also published in the American Journal of Science, Series III, Vol. 46, pp. 379–392, and 448–466.)

Scott, W. B.—"*The Mammals of the Deep River Beds.*" American Naturalist, Vol. XXVII, p. 659.

The author cites a species of *Chalicotherium* as found in the upper strata of this formation.

Zittel, Karl A.—"*Handbuch der Palæontologie,*" Band IV, "*Säugethiere.*"

On p. 26 the author gives a figure of the right forearm of *Ancylotherium.* On p. 205 figures are given of the fore and hind feet of *Hyracops* Marsh (*Meniscotherium* Cope) and of *Dendrohyrax. Meniscotherium* is referred to the *Condylarthra* Cope (*Mesodactyla* Marsh), under the family *Meniscotheridæ.* On p. 309 the *Chalicotheridæ* are recognized as the Seventh Family in the Order *Perissodactyla.*

The following translation of the pages of Zittel, which relate to the Chalicotheroidea, was made by the writer on Oct. 9, 1907, and is here given, as up to the present time no English translation of the Fourth Volume of Zittel's work in its original or revised form has appeared:

Family Chalicotheridæ.

Nasals long, projecting freely. Narial openings short. Orbits open behind. Dental formula I. $\frac{3-0}{3-0}$: C. $\frac{0}{1-0}$: Pm. $\frac{3}{3}$: M. $\frac{3}{3}$. *Incisors and canines weak or altogether wanting. Upper premolars simpler than the molars, and possessing an inner cusp. Upper molars with W-shaped outer wall and two conical inner cusps. The lower molars formed of two V-shaped crescents, the inner ends of the crescents where they come together developing into two pointed minute tubercles.* M_3 *without a talon. The fore and hind feet three-toed, plantigrade, the unguals deeply cleft, strongly curved, claw-shaped. The third trochanter of the femur slightly developed.*

This family, which is widely distributed in Europe, Asia, and America, is composed of genera of considerable size, the dentition of which reveals marked similarity to that of the *Meniscotheridæ* and the *Titanotheridæ.* Incisors and canines are still present in the older forms, but in *Chalicotherium* are partially or wholly aborted. There is a diastema between the canines and the cheek-teeth. The skull most nearly compares with that of *Palæosyops* and *Brontotherium,* the nasals project freely, and are smooth, without bony rugosities on the upper surface. The frontal region is broad, the occiput low; the auditory bullæ are cylindrical. The three-toed fore and hind feet and other portions of the skeleton which occur at Pikermi, Sansan, and Grive-St.-Alban mingled with the fragments of the skulls and teeth of *Chalicotherium* and *Macrotherium* differ so greatly from those of other Perissodactyls that they were assumed to be the remains

of edentates by Cuvier, Kaup, Lartet, Gaudry, and Gervais, and were by them referred to independent genera. The ulna and radius, however, are much more like those of *Diplacodon* and *Palæosyops* than those of the Edentata. The humerus is remarkable by reason of the weak development of the deltoid crest, being thus differentiated from the Titanotheridæ as well as from the Edentates. The entepicondylar foramen which is characteristic of most Edentates is wanting. The carpus in the proximal row has four and in the distal row three bones. The trapezium and metacarpal V are obsolete. A coössification of two of the carpals, which is common in the Edentata, does not occur. Mc II is the shortest, nevertheless quite as thick as the two outer metacarpals of which Mc IV attains the greatest length; their distal articulating extremities are strongly convex and articulate with the first phalanges by a simple groove, which more particularly in the case of the outer digits lies almost entirely upon the superior surface of the bone. The distal articulating extremities of the first phalanges are, like the two which succeed them, deeply excavated in the middle, bipartite, and unusually large, so that the digits were capable of being strongly bent backward even to the extent of partially covering the metacarpals. With this form of articulation, which strongly recalls that occurring in the Edentata, is united the deep fission of the terminal phalanges, much more like the claws of sloths than of ungulates, though resembling the cleft hoofs of the Typotheridæ and the Hyracoids among the Ungulata. The hind limbs are shorter than the fore limbs. The pelvis is unknown. The femur has an exceedingly weak third trochanter situated high up upon the shaft. The tibia and fibula are separate. The calcaneum is characterized by a very strong sustentaculum and broad articulating surfaces for the low astragalus, the distal truncated facets of which rest upon the navicular and in part upon the cuboid. The tibial trochlea of the astragalus is moderately arched and only feebly concave. The three metatarsals are noticeably shorter than the metacarpals; the phalanges are formed like those of the fore foot.

The Chalicotheridæ in their dentition and the structure of the skull show close affinity to the Titanotheres, but are strongly differentiated from them by the form of the highly mobile digits adapted to grasping, and by the deeply cleft, curved, and clawlike terminal phalanges. This structure of the feet induced Cuvier, Kaup, Lartet, Gaudry, and Gervais to attribute the foot bones, which they described under the generic names *Macrotherium*, *Ancylotherium*, *Schizotherium*, and *Pernatherium*, to the Edentata, assigning these genera a place near the genus *Manis*, in spite of the fact that the carpus and the tarsus have preserved the typical features of the corresponding portions of the Perissodactyla. Cope regards the Chalicotheridæ as forming a distinct order (*Ancylopoda*), but they most probably only represent a highly specialized offshoot of the Perissodactyla. Osborn regards them as descended from the *Meniscotheridæ*, with which both in dentition and skeletal structure they show numerous resemblances.

They were without doubt ungainly plantigrades, capable of using their anterior feet for scraping and grasping.

Their geological distribution extends from the upper Eocene to the Pliocene.

Schizotherium Gervais (Zoöl. and Paléont. Gén. II, p. 58). The genus was founded upon the phalanges and metapodials of a small Chalicothere from the phosphorites of Quercy. (*Schiz. priscum* Gaudry, sp.) In the same deposits are found teeth which were described by Gaudry as *Chalicotherium modicum*, but which in all probability belong to the same species.

? *Pernatherium* Gervais (Journal de Zoologie, V, p. 424). Only a calcaneum, a metatarsal, and a few fragments of other bones exist. Eocene (Calcaire de St. Ouen), Paris.

? *Limognitherium* Filhol (Compt. Rendus Hebd. 1880, p. 1580). Only large metacarpals about 0.18 m. in length are known. Upper Eocene. (Quercy Phosphorites).

Macrotherium Lartet (*Anisodon* Lartet). Fig. 252. Dental formula I. $\frac{?}{3}$, C. $\frac{?}{1}$, P. $\frac{3}{3}$, M. $\frac{3}{3}$. Skull with a weak sagittal crest, the parietals converging, not flattened, frontals bordering the orbits which are only partially surrounded by a bony ring. The occipital condyles moderately produced and on the under side of the skull extended somewhat forward. Auditory bullæ strongly inflated, having the form of a bent cylinder. The mastoid process strongly developed. The mandible very high, straight on its lower edge, like *Palæosyops*, the hind margin of the ascending ramus without a forward projection. Upper incisors and canines are not known. The molar series increasing in size posteriorly. The breadth of the three upper premolars exceeds their length; the outer wall of the two anterior premolars shows one cusp, P^4 two cusps; on the inner side all the premolars have but one large inner cusp, which sends forth behind to the outer wall a crescentic ridge. The three molars are quadrate with a W-shaped outer border, a large anterior and a small posterior inner cusp. The mandible has three incisors and a canine, which are closely grouped together. The last premolar and the molars of the lower jaw consist of two bluntly curved crescents, which unite on the inner side in two separate, slightly thickened points. P_3 has one somewhat lengthened and compressed sharpened cusp. Middle Miocene of Sansan (Gers), Bon Repos and St. Gaudens (Haute Garonne), Grive-Saint-Alban (Isère), Haeder in Southern Bavaria and Steinheim, Württemberg (*M. grande* Lartet); also in the lower Miocene in the neighborhood of Ulm (*M.* [*Chalicotherium*] *Wetzleri* Kowalewsky).

At Sansan and Grive-Saint-Alban there were found skeletal remains, which were originally described as *Macrotherium sansaniense* Lartet, but which according to Filhol and Depéret undoubtedly must be regarded as remains of the skull and teeth of *Anisodon* Lartet. The bones of the feet possess essentially the same characteristics

as those of *Ancylotherium*, though the deeply divided terminal phalanges are more hoof-shaped and less claw-like. The articular surface of the first phalanges at their proximal end terminates abruptly and is not advanced on the anterior extremity as much as in *Ancylotherium*. The fore limbs of *Macrotherium* are considerably longer than the hind limbs; the humerus is longer and not so stocky as in *Ancylotherium* and without an olecranal fossa. The ulna and radius are slender; the olecranon of the ulna short. The carpus is composed of two series of moderately elongated bones, the *os magnum* larger than in the case of *Ancylotherium*, articulating with the lunar and the scaphoid. The tibia is only half as long as the radius. The calcaneum has a strongly developed sustentaculum, the astragalus is distally truncate, very low and broad, the anterior and upper articular condyle weakly furrowed. The navicular and cuboid are low. The metatarsals are only half as long as the metacarpals and like the latter increase in diameter from within outwardly.

Chalicotherium Kaup (*Nestoritherium* Kaup, *Ancylotherium* Gaudry). Figs. 253, 254. Dental formula I. $\frac{0}{0}$; C. $\frac{0}{1-0}$; Pm. $\frac{3}{3}$; M. $\frac{3}{3}$. The cheek-teeth both above and below increase in size from before backwards. The upper molars are very like those of *Palæosyops;* the W-shaped outer wall consisting of two V-shaped eminences; both inner cusps are conical, the posterior cusp decidedly weaker than the anterior, and generally united with the outer cusp by a narrow crest. The upper premolars are smaller and simpler in structure than the molars, the outer wall lightly indented and only an inner cusp being present. All of the three lower molars are formed of two V-shaped crescents opening inwardly and at the points where they unite developing two small pointed cusps. Incisors and canines are wanting in the upper jaw; the lower jaw possesses occasionally a small canine tooth separated from the anterior premolar by a diastema; the lower incisors are wanting or are at most very feebly developed. The skull is characterized by a short muzzle with the narial openings extending but a short distance backwardly; the nasal bones are broad and projecting. The frontals and parietals unite to form a broad, smooth, ascending cranium without sagittal crest; the very stout zygoma has its origin far back; the orbits are small and not enclosed. The symphysis of the mandible is short and thin. Upper Miocene. *Ch. goldfussi*, Kaup (Eppelsheim near Worms and Siebenhirten near Vienna), *Ch. pachygnathus* Wagner (Pikermi), *Ch. baltavarense* Pethö (Baltavar, Hungary), *Ch. sivalense* Falc. (Siwalik Hills), *Ch. sinense* Owen (China).

At Eppelsheim, Pikermi, and on the Island of Samos a number of different bones of *Chalicotherium* have been found which hitherto have generally been regarded as the remains of Edentata. Cuvier designated a claw-like phalanx from Eppelsheim as *Pangolin (Manis) gigantesque*. Similar phalanges and nearly complete extremities were described by Gaudry, Lartet, and Hensel from Pikermi as *Ancylotherium*. The fore and hind limbs of *Chalicotherium* (*Ancylotherium*) are robust, nearly of equal length,

and possessed of three digits. The humerus is robust, with a comparatively weakly developed deltoid crest, at the distal end somewhat broadened transversely, with a deep olecranal fossa and a well developed epicondyle. The radius and ulna are scarcely longer than the fore arm, of nearly equal size, like *Tapirus*, *Diplacodon*, and *Brontotherium*, closely appressed and at the distal end coössified. The carpus has four bones in the proximal series, three in the distal series which are short. The *os magnum* in front is unusually small, nevertheless behind it increases in size, articulating above with the scaphoid and the lunar. The unciform is very large, articulating to nearly an equal extent with the cuneiform and the lunar. The trapezoid lies under the scaphoid; its upper articulating surface is hemispherical and unites behind with the lower facet, so that the scaphoid is able to glide upon the upper articular surface of the second metacarpal which is produced behind. The three metacarpals have almost an equal development, their distal articulating extremities being without a median keel. On the second phalanges the distal articulating surface is almost wholly confined to the upper surface of the bone, and thereby reveals the fact that the strong, claw-shaped, crooked, and deeply divided terminal phalanges were capable of being strongly bent upward. The excavated proximal articulating surfaces of the terminal phalanges are strongly keeled in the middle. A complete coalescence of the first two phalanges (probably of the outer finger) has been observed by Gaudry. The femur is like the humerus in length, without a third trochanter. The tibia is very strong, scarcely shorter than the radius. The fibula is probably wholly separate. The tarsus is low and broad. The calcaneum possesses a moderately elongated tuberosity, distally truncate, the two facets for the astragalus being large. The cuboid is low. The navicular is truncate above, plane. The ectocuneiform is very broad, the mesocuneiform small. The three metatarsals are shorter than the metacarpals, the one in the middle being the longest. The phalanges are formed as in the fore foot, with the exception that the terminal phalanges are somewhat more massive and less deeply divided.

Moropus Marsh. (American Journal Science, Third Series, Vol. XIV, pp. 249, 362.) Fig. 255. This genus was originally erected by Marsh upon foot bones derived from the upper Miocene of the John Day in Oregon (*M. distans* and *senex* Marsh), and was referred to the Edentata. A third species occurs in the lower Pliocene (Loup Fork of Nebraska) (*M. elatus* Marsh). In the John Day deposits as well as in Nebraska there occurred together with the bones of the extremities of *Chalicotherium* teeth referable to the species, which in their size correspond to those of *Schizotherium modicum* Gaudry, and are characterized by the fact that the inner cusp of the upper premolar is connected with the outer wall of the tooth by two cross-crests.

1894.

AMEGHINO, FLORENTINO—"*Enumeration Synoptique des Espèces des Mammifères Fossiles des Formations Eocènes de Patagonie.*" Bol. Acad. Nat. Ciencias, Córdoba, Vol. XIII, pp. 259–452.

Ameghino regards the *Homalodontotheridæ* as the ancestors of the *Chalicotheriidæ* of Europe and North America.

FILHOL, H.—"*Observations Concernant quelques Mammifères Fossiles Nouveaux du Quercy.*" Annales des Sciences Naturelles, Zoölogie, Tome XVI, pp. 129–150.

On pp. 141–150 the author discusses at some length the structure of the manus and pes of *Schizotherium priscum* Gervais, and concludes his paper with the assertion that *Chalicotherium* and *Macrotherium* are related to the Perissodactyla.

SCOTT, W. B.—"*Notes on the Osteology of Agriochœrus Leidy* (*Artionyx O. & W.*)." Proceedings of the American Philosophical Society, Vol. XXXIII, pp. 243–251.

Dr. Scott shows that the genus *Artionyx* of Osborn & Wortman is a synonym for *Agriochœrus* Leidy, previously only known from the skull. The proposed suborders *Perissonychia* and *Artionychia* of the Ancylopoda, to which *Agriochœrus* is not related, must therefore be abandoned.

1895.

OSBORN, H. F.—Bulletin American Museum Natural History, Vol. VII, p. 98.

Professor Osborn describes *Sphenocœlus uintensis* gen. et sp. nov.

1896.

ROGER, DR. OTTO—"*Verzeichniss der bisher bekannten fossilen Säugethiere,*" p. 196–197.

Under the suborder *Ancylopoda* Cope, are cited the following species:

Schizotherium priscum Gaudry, Syn. *C. modicum* Gaudry?; **Pernatherium** sp. Gervais; **Limognitherium ingens** Filhol; **Macrotherium grande** Lartet, Syn. "*Pangolin gigantesque*" Cuvier; *Anoplotherium grande* Lartet; *Anisodon magnum* Lartet, *Macrotherium giganteum* Cuvier, *Macrotherium sansaniense* Lartet, *Chalicotherium anisodon* Blainville; **Macrotherium wetzleri** Kowalesky, Syn. *Anisodon schinzii* von Meyer; **Chalicotherium antiquum** Kaup, Syn. *Anisodon minus* Lartet; **Chalicotherium goldfussi** Kaup; **Chalicotherium pachygnathum** Wagner, Syn. *M. pentelici* Roth & Wagner, *Ancylotherium pentelici* Gaudry, *Chalicotherium wagneri* Schlosser; **Chalicotherium baltavarense** Pethö; **Chalicotherium sivalense** Falconer and Cautley, Syn. *Nestoritherium sivalense* Falconer, *Nestoritherium posterigenium* Falconer, *Manis sindiensis* Lydekker; **Chalicotherium sinense** Owen; **Chalicotherium bilobatum** Cope; **Moropus distans** Marsh; **Moropus senex** Marsh; **Moropus elatus** Marsh.

1897.

WORTMAN, JACOB L.—"The Ganodonta and their Relationship to the Edentata." Bulletin American Museum Natural History, Vol. IX, p. 60.

The author quotes Marsh in reference to the edentate relationships of *Moropus*.

1898.

TROUESSART, E. L.—"*Catalogus Mammalium tam viventium quam Fossilium.*" Vol. II, pp. 696–698. Under the Ungulata as the Fourth Family are given the Chalicotheriidæ. Five genera are recognized: *Schizotherium* Gaudry, *Pernatherium* Gervais, *Macrotherium* Lartet, *Chalicotherium* Kaup, and *Moropus* Marsh.

Limognitherium Filhol is suppressed as a synonym of *Schizotherium* Gaudry. *Anisodon* Lartet is sunk as a synonym, in part of *Macrotherium*, in part of *Chalicotherium; Nestoritherium* Kaup is sunk as a synonym of *Chalicotherium; Ancylotherium* Gaudry is suppressed as being in part synonymous with *Schizotherium* Gaudry, and in part with *Chalicotherium* Kaup. *Colodus* Wagner is treated as in part being synonymous with *Chalicotherium* Kaup.

1899.

MATTHEW, W. D.—"*A Provisional Classification of the Fresh-water Tertiary of the West.*" Bulletin American Museum Natural History, Vol. XII, pp. 19–75.

On p. 58 the author lists *Chalicotherium bilobatum* Cope from the White River Beds under the *Ancylopoda;* on p. 63 *Moropus distans* and *senex* Marsh are listed from the John Day Beds under the *Perissodactyla,* as " ?Chalicotheriidæ (*aut Edentata*) "; and on p. 72 *Moropus elatus* Marsh is cited as coming from the Loup Fork Beds, and in the same manner is referred with doubt to the *Chalicotheriidæ* or the *Edentata.*

1904.

WEBER, MAX—"*Die Säugethiere, Einführung in die Anatomie und Systematik der Recenten und Fossilen Mammalia.*"

On pp. 694–696 the Ancylopoda are briefly characterized as an extinct order, and the author apparently is inclined to view with favor the view of Ameghino that the *Homalodontheriidæ* (*sic*) are to be included in the Ancylopoda. The time-honored figures of the foot of *Macrotherium* by Gervais are given, with the figure of the foot of *Homalodontherium* (*sic*) after Ameghino.

1906.

PETERSON, O. A.—"*The Miocene Beds of Western Nebraska and Eastern Wyoming and Their Vertebrate Fauna.*" Annals of the Carnegie Museum, Vol. V, 1906, pp. 60–63.

The genus *Moropus* is here placed on a firm foundation by comparing specimens recently acquired by the Carnegie Museum with the types of *Moropus.*

1907.

PETERSON, O. A.—"*Preliminary Notes On Some American Chalicotheres.*" American Naturalist, Vol. XLI, December, 1907, pp. 733–752, figs. 1–26.

In this paper, on page 735, for the first time the type material of *Moropus distans, senex,* and *elatus* is illustrated. Specimens from the Agate Spring Fossil Quarries,

obtained by the Carnegie Museum, are also figured on the same page, in order to show some of the more distinctive characters of *Moropus elatus*. The paper gives a brief survey of the osteology of the genus and concludes by referring it to the Perissodactyla.

1908.

Holland, W. J.—"*A New Species of the Genus Moropus.*" Science, N. S., Vol. XXVIII, pp. 809–810.

Moropus petersoni is briefly characterized and compared with *Moropus elatus*.

Pilgrim, Guy E.—Records of the Geological Survey of India, Vol. XXVII, p. 156.

Macrotherium naricum sp. nov. is described from the Tertiary of Baluchistan.

Barbour, Erwin H.—Nebraska Geological Survey, Publication III, Part II, p. 1.

Moropus cooki sp. nov. is described.

1909.

Barbour, Erwin H.—Nebraska Geological Survey, Publication III, p. 217.

Moropus parvus is named and described.

1910.

Gregory, W. K.—"*The Orders of Mammals.*" Bull. Amer. Mus. Nat. Hist., Vol. XXVII, pp. v+524.

On pp. 397–400 Dr. Gregory epitomizes what is known as to the Chalicotheroidea and states that the view of Osborn and Peterson that the Chalicotheres are an aberrant family of the Perissodactyls is apparently justified.

Pilgrim, Guy E.—"*Notices of New Mammalian Genera and Species from the Tertiaries of India.*" Records of the Geological Survey of India, Vol. 40, pp. 634–640.

The genus *Phyllotillon* is erected for the reception of *Macrotherium naricum* Pilgrim.

1911.

Merriam, J. C.—"*Tertiary Mammal Beds of Virgin Valley and Thousand Creek, Northwestern Nevada.*" University of California Publications, Bulletin of the Department of Geology, Vol. VI, 1911, pp. 267–271.

A number of fragments of teeth and footbones of the Chalicotheres are referred to *Moropus*, and the correlation of the strata of the Virgin Valley with the Lower Harrison Beds is suggested.

Schlosser, Max—"*Grundzüge der Paläontologie.*" Zittel. Second and Revised Edition, edited by Schlosser.

Abth. II, p. 467, Schlosser makes the *Chalicotheriidæ* the Fifth Family of the *Perissodactyla*, and modifies certain statements made in the First Edition by Zittel in the light of later information.

1913.

OSBORN, H. F.—"*Eomoropus, An American Eocene Chalicothere.*" Bulletin American Museum Natural History, Vol. XXXII, pp. 261–274.

The author erects a new genus for the reception of *Triplopus amarorum* Cope, which he classifies as a Chalicotheroid.

PETERSON, O. A.—"*A New Species of Moropus (M. hollandi) from the Base of the Middle Miocene of Western Nebraska.*" Science, N. S., Vol. XXXVIII, p. 673.

NOTE.

Since this memoir has passed through the press a careful reëxamination of the scapula doubtfully referred by us to the genus *Moropus* (see p. 230 and fig. 77 on p. 332) has led us to the conclusion that its identification with *Moropus* is in error.

It may in passing be said that the dotted line in figure 77 has been started by the artist a little too high up on the supra-scapular border.

While we hesitate to affirm that it is the scapula of a Titanothere, it nevertheless more nearly resembles that element as found in the representatives of this family occurring in the lower Oligocene. The discovery of the remains of a Titanothere in the upper beds of the lower Miocene is, in view of what has hitherto been known as to their distribution, surprising, to say the least.

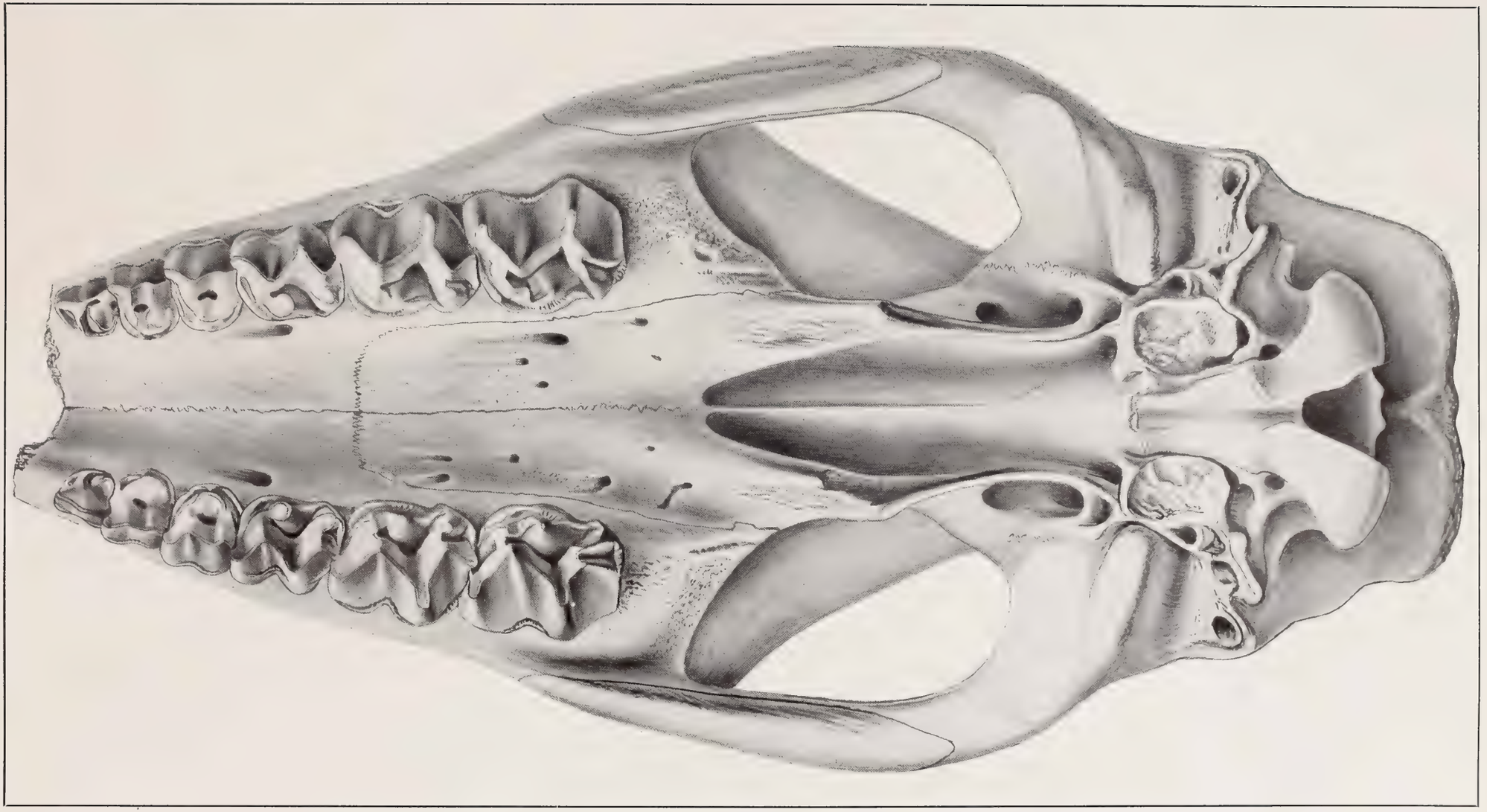
CORRIGENDA.

P. 205, 14th line from top for *Phillotillon* read *Phyllotillon.*

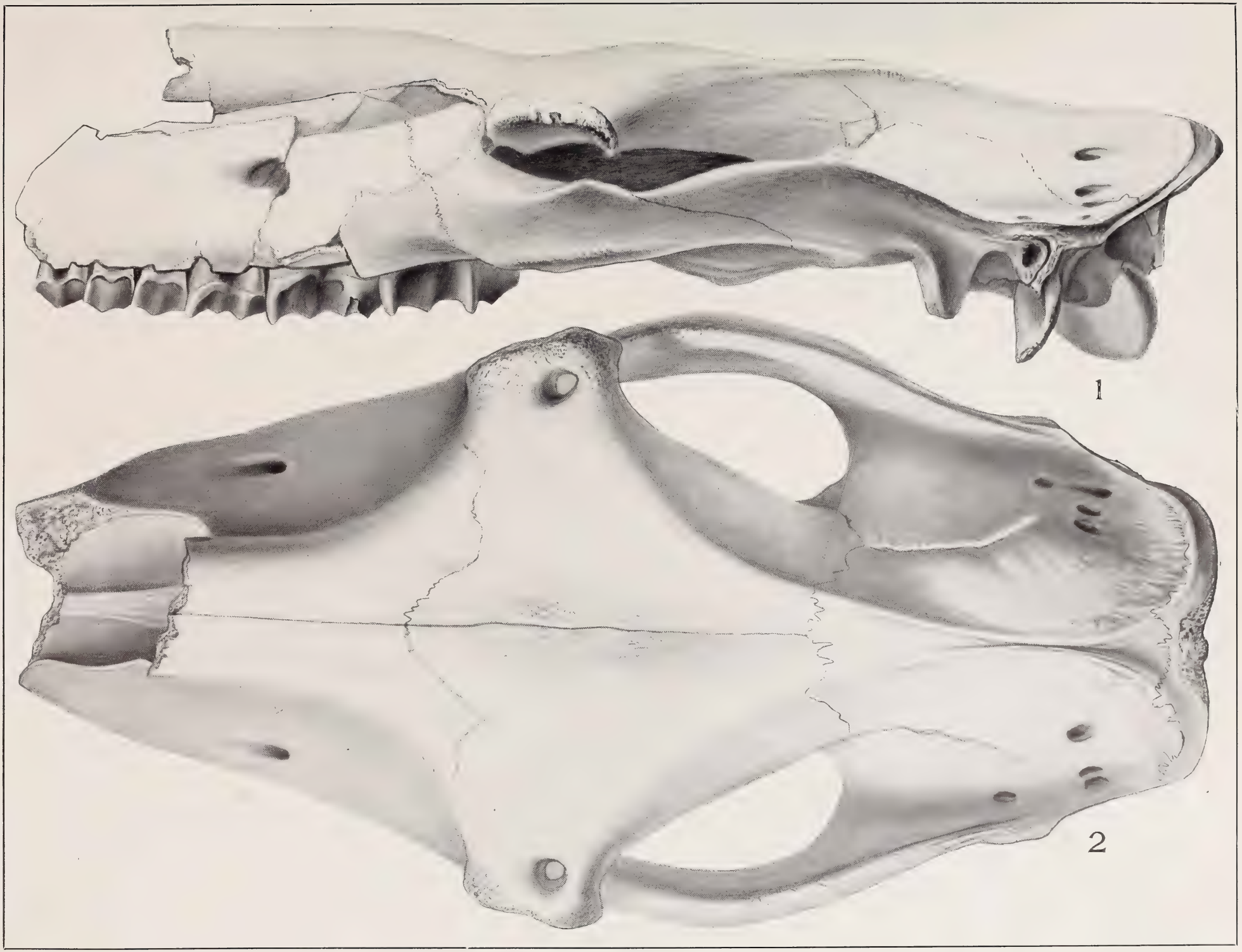
Pp. 207 and 217. For *pentelicum* read *pentelici.*

Plate LXVIII, fig. 1. Through an error of the draughtsman the sesamoid is represented with its heavy end upward, the reverse of its true position, which is correctly shown on Plate LXIX, fig. 1.

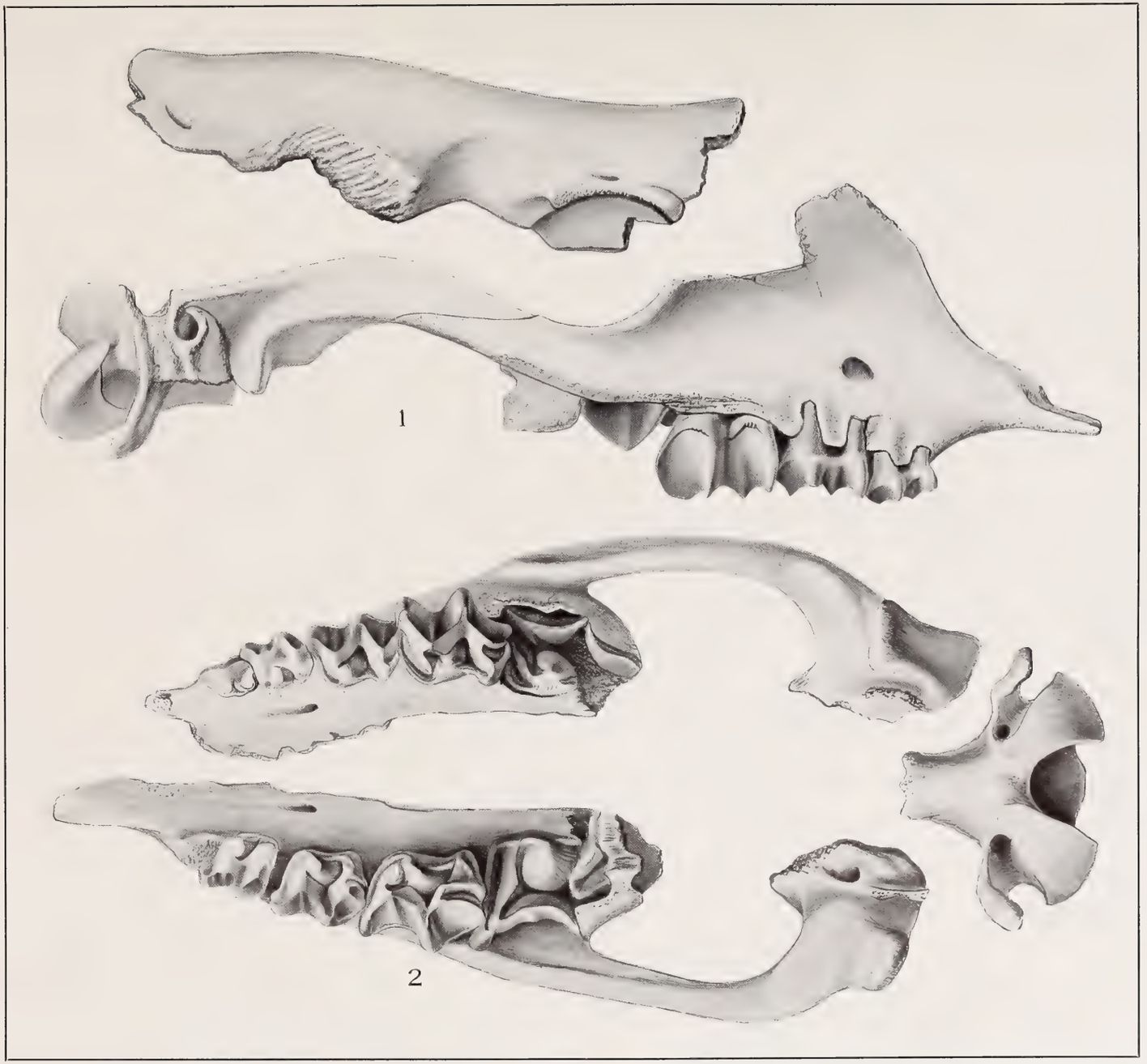
SUPERIOR, LATERAL, AND PALATAL VIEWS OF SKULL OF *M. elatus* (No. 2103). $\times\frac{1}{3}$.



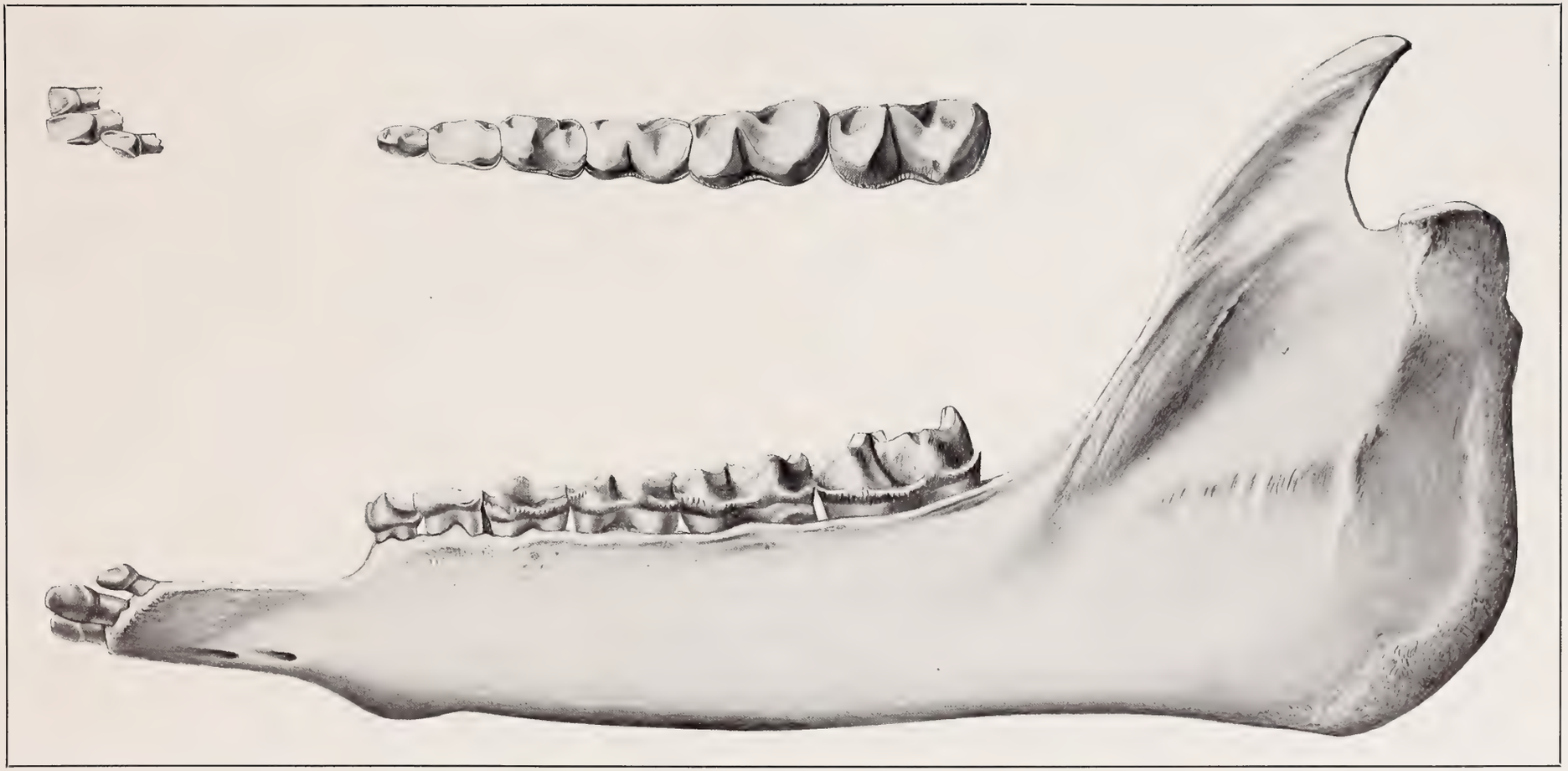
PALATAL VIEW OF SKULL OF *Moropus elatus* MARSH (No. 2103). $\times\frac{1}{2}$. DRAWN BY S. PRENTICE.



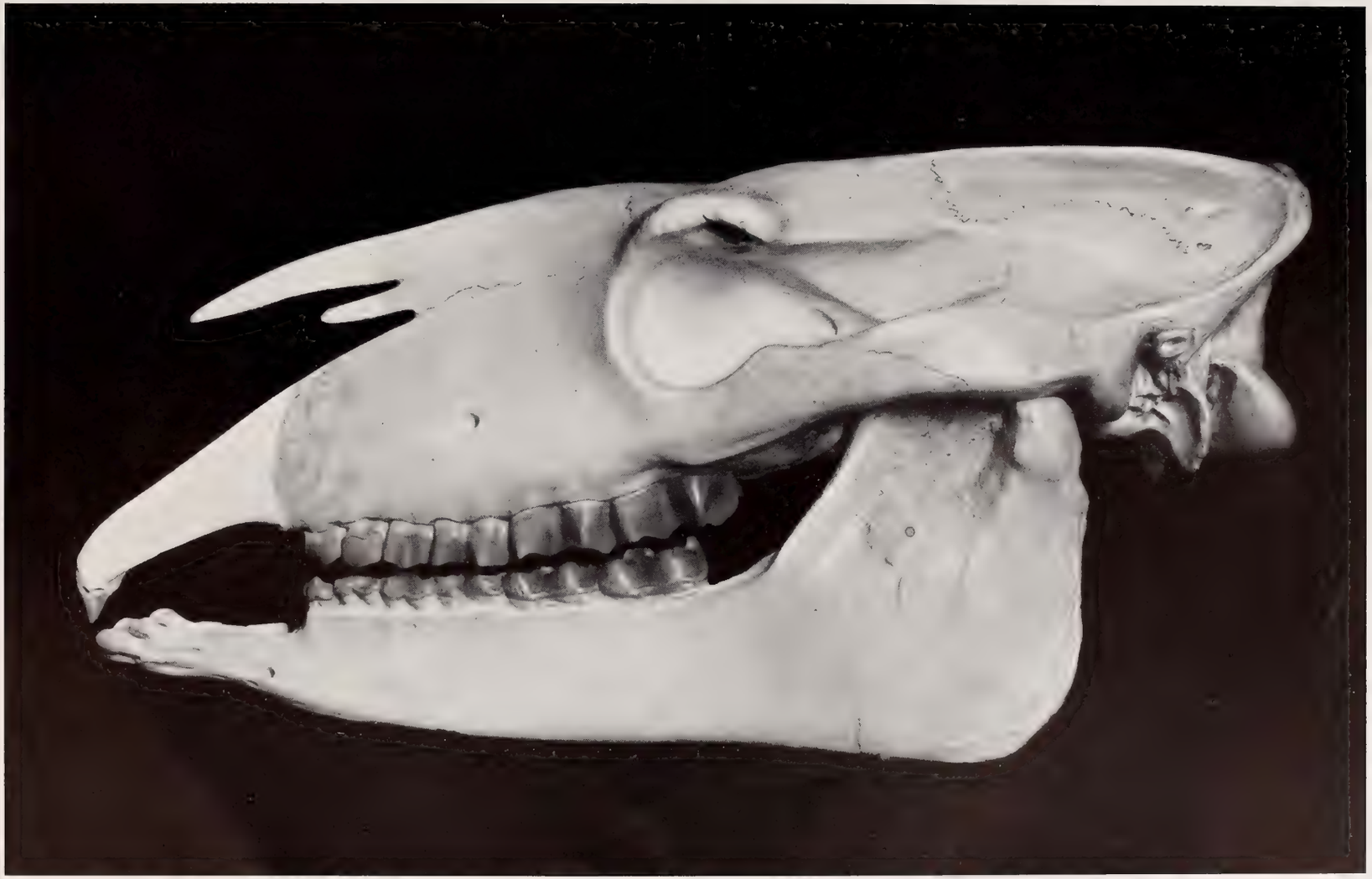
LATERAL AND SUPERIOR VIEWS OF SKULL OF *M. elatus* (NO. 2103)



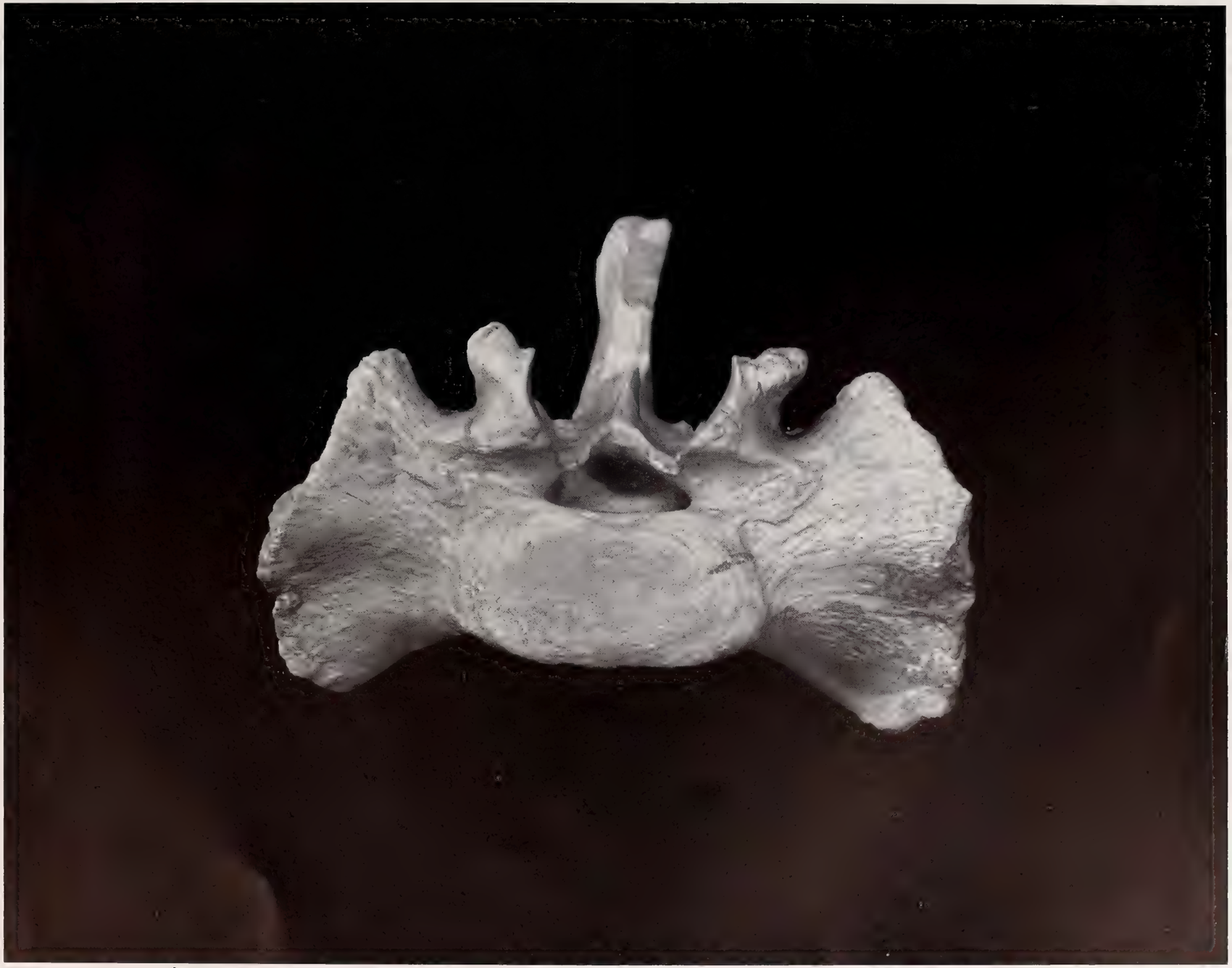
LATERAL AND SUPERIOR VIEWS OF *M. petersoni, juv.* (NO. 1707). $\times\frac{1}{2}$. SHOWING MILK-DENTITION, AND FIRST AND SECOND PERMANENT MOLARS.



MANDIBLE OF *M. elatus* (No. 1604). $\times\frac{1}{2}$

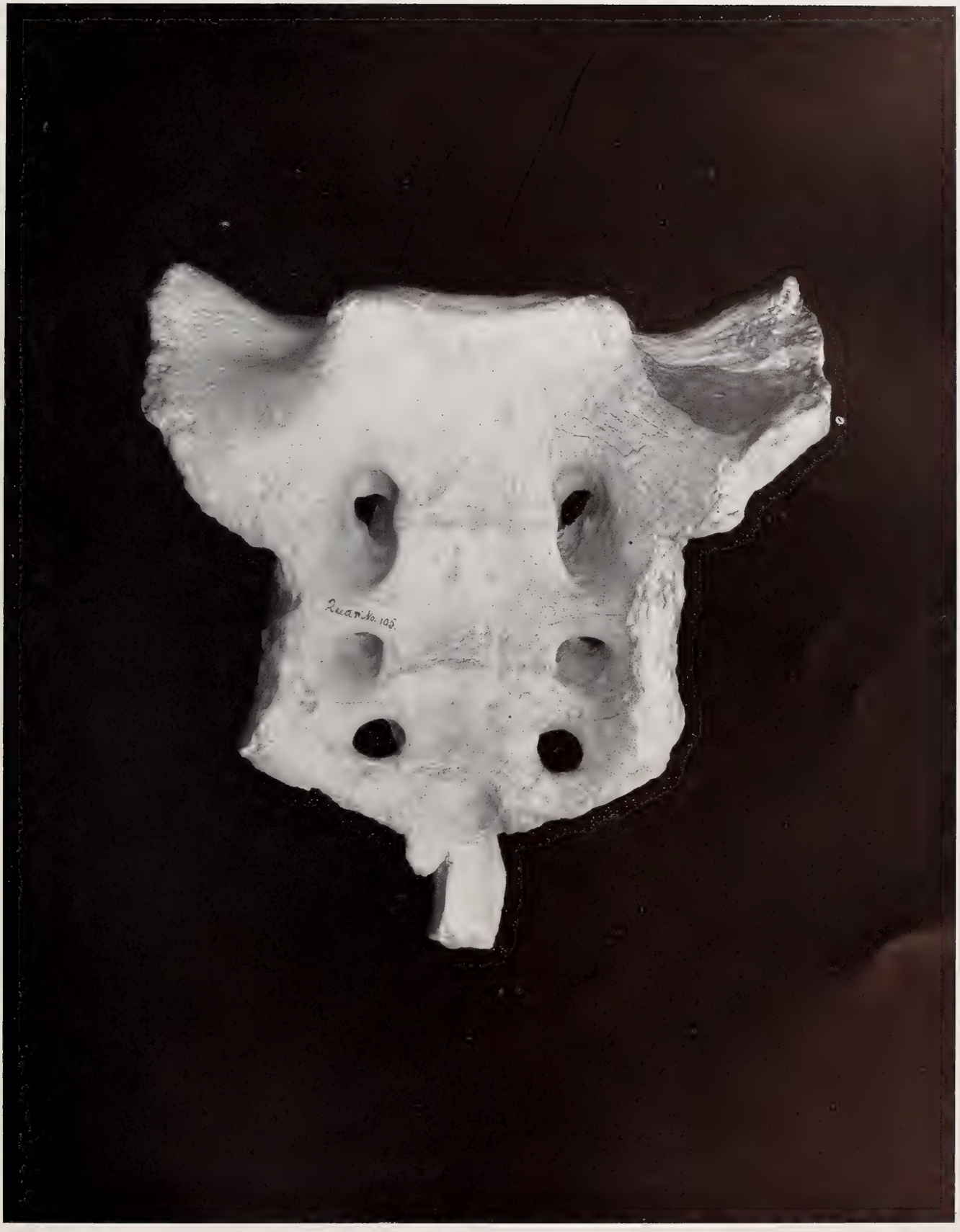


LEFT LATERAL VIEW OF SKULL OF *M. elatus* (NO. 2103) AS RESTORED BY W. J. HOLLAND. $\times\frac{1}{3}$.



ANTERIOR VIEW OF FIRST SACRAL VERTEBRA. (No. 1704 C. M. Cat. Vert. Foss.) About $\frac{3}{5}$ nat. size.

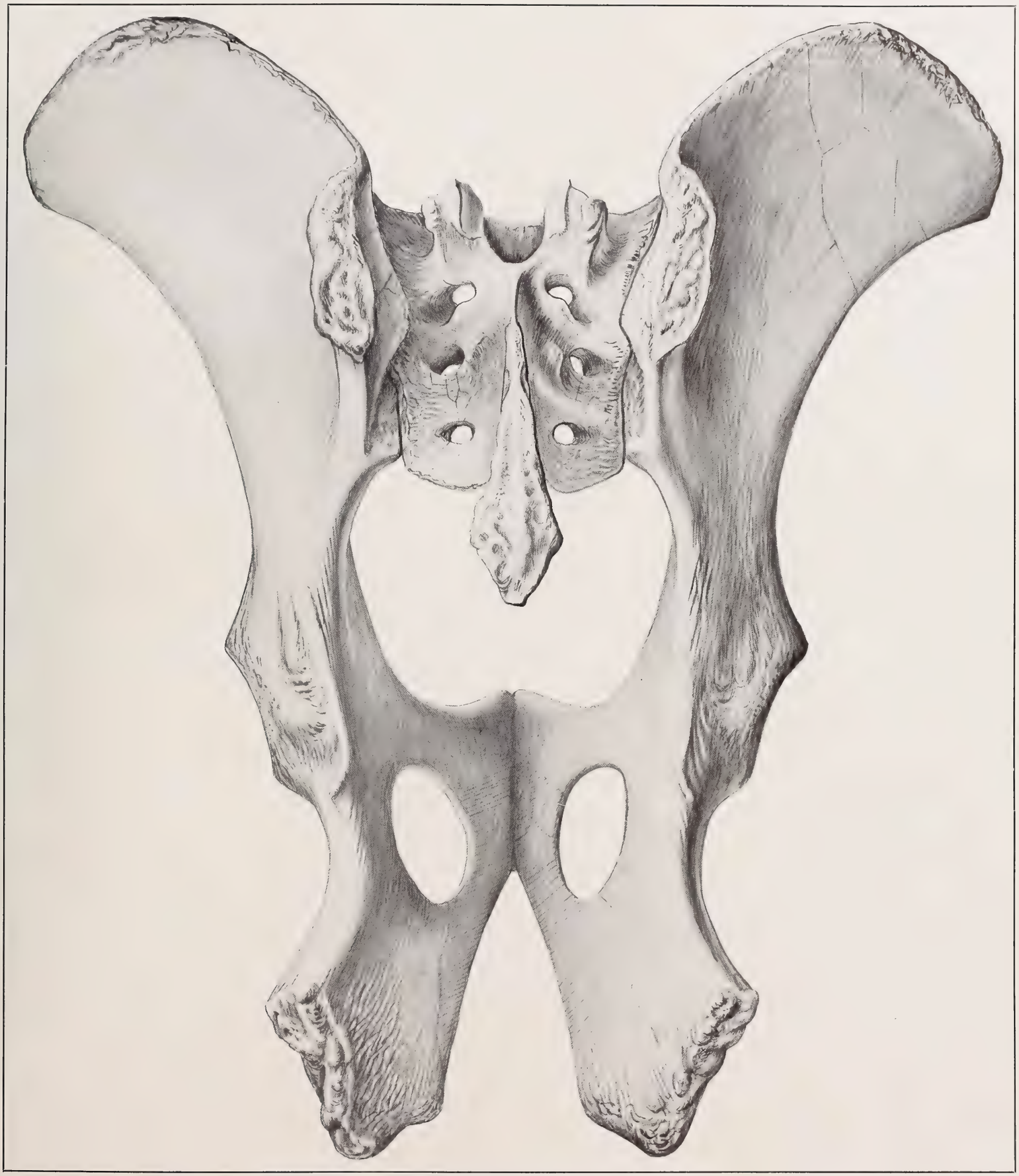
SUPERIOR VIEW OF SACRAL VERTEBRÆ (No. 1704). About $\frac{3}{5}$ nat. size.



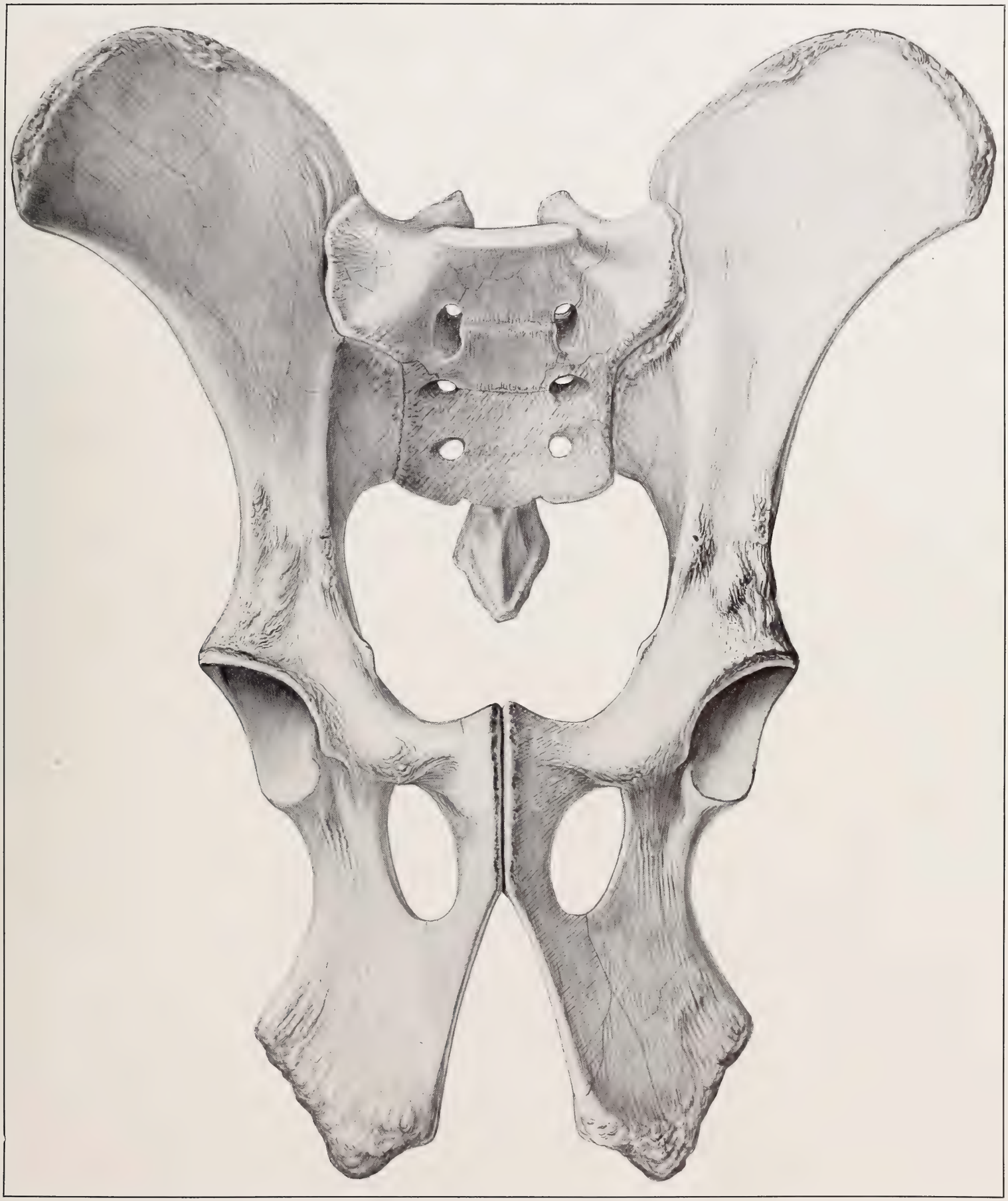
INFERIOR VIEW OF SACRAL VERTEBRÆ (No. 1704). About $\frac{2}{3}$ nat. size.

LATERAL VIEW OF SACRUM OF *M. elatus* (NO. 1704). $\times\frac{1}{3}$.

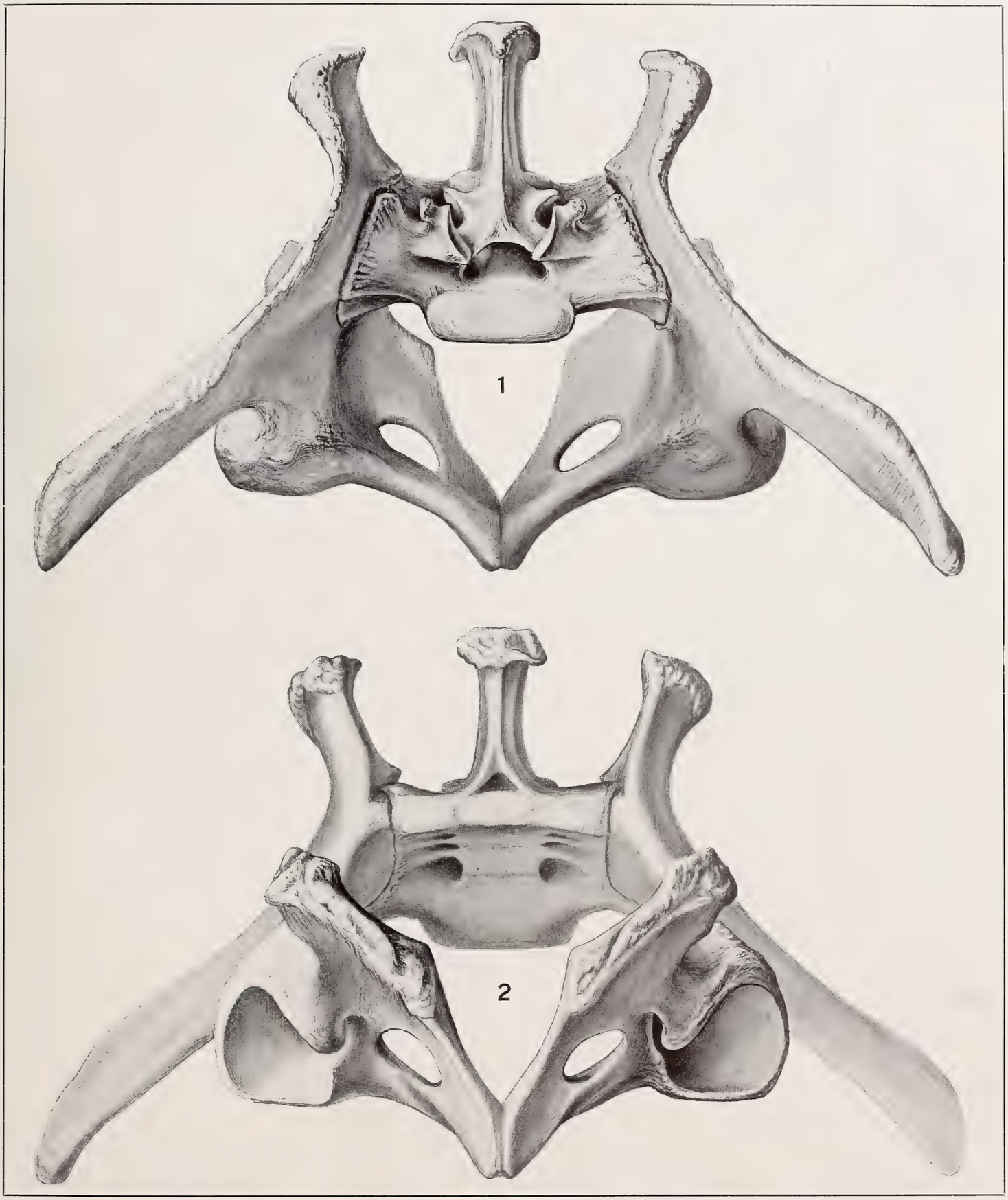
LATERAL VIEW OF PELVIS OF *M. elatus* (No. 1706). $\times\frac{1}{3}$.



DORSAL VIEW OF PELVIC GIRDLE OF *M. elatus* (No. 1706). $\times\frac{1}{3}$.



VENTRAL VIEW OF PELVIC GIRDLE OF *M. elatus* (No. 1706). $\times\frac{1}{3}$.

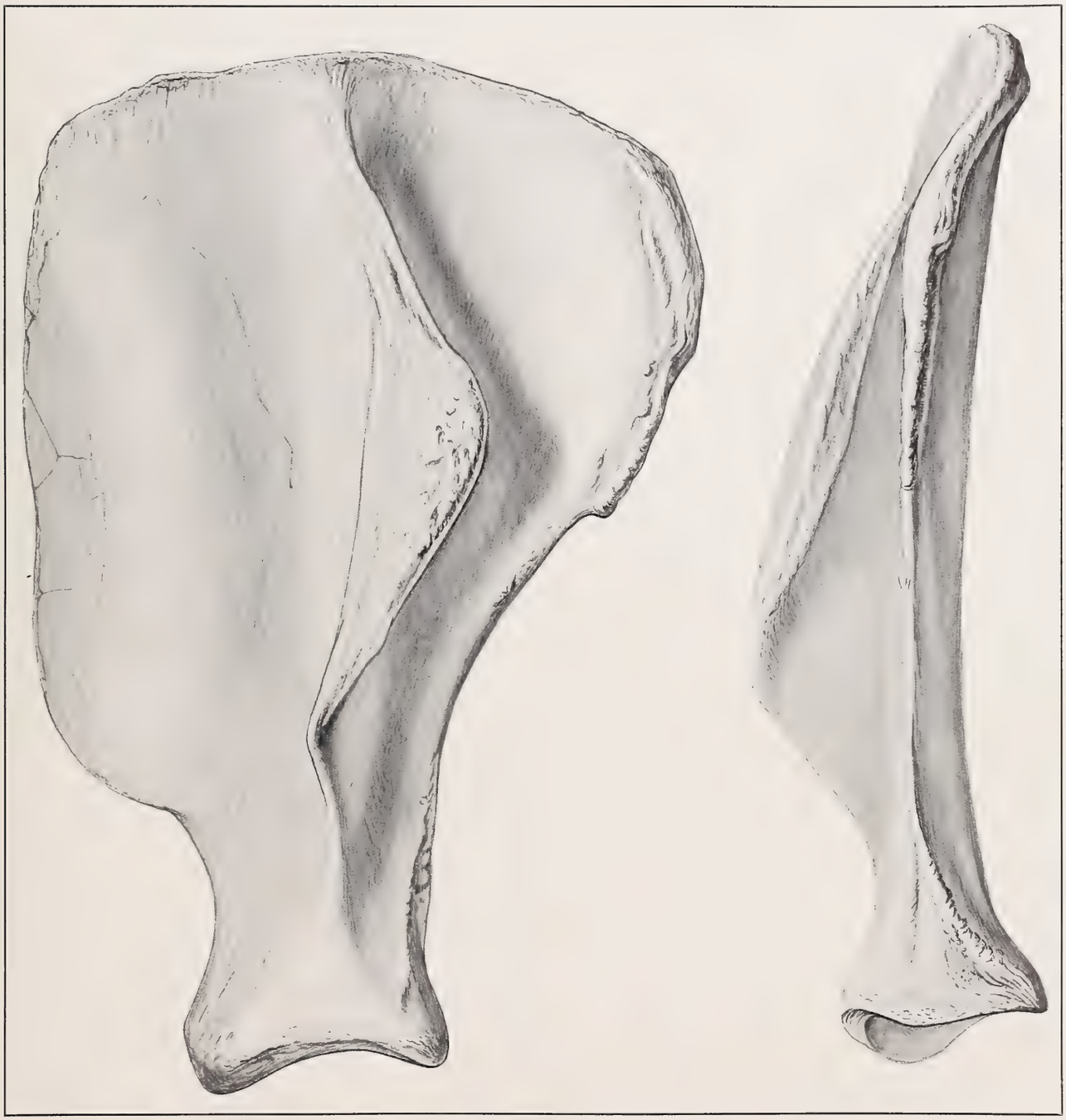


PELVIC GIRDLE OF *M. elatus* MARSH. 1. ANTERIOR VIEW; 2. POSTERIOR VIEW.

RIBS 1–5 OF *M. elatus* (NO. 1604), RIGHT SIDE. ABOUT ONE-FOURTH NAT. SIZE

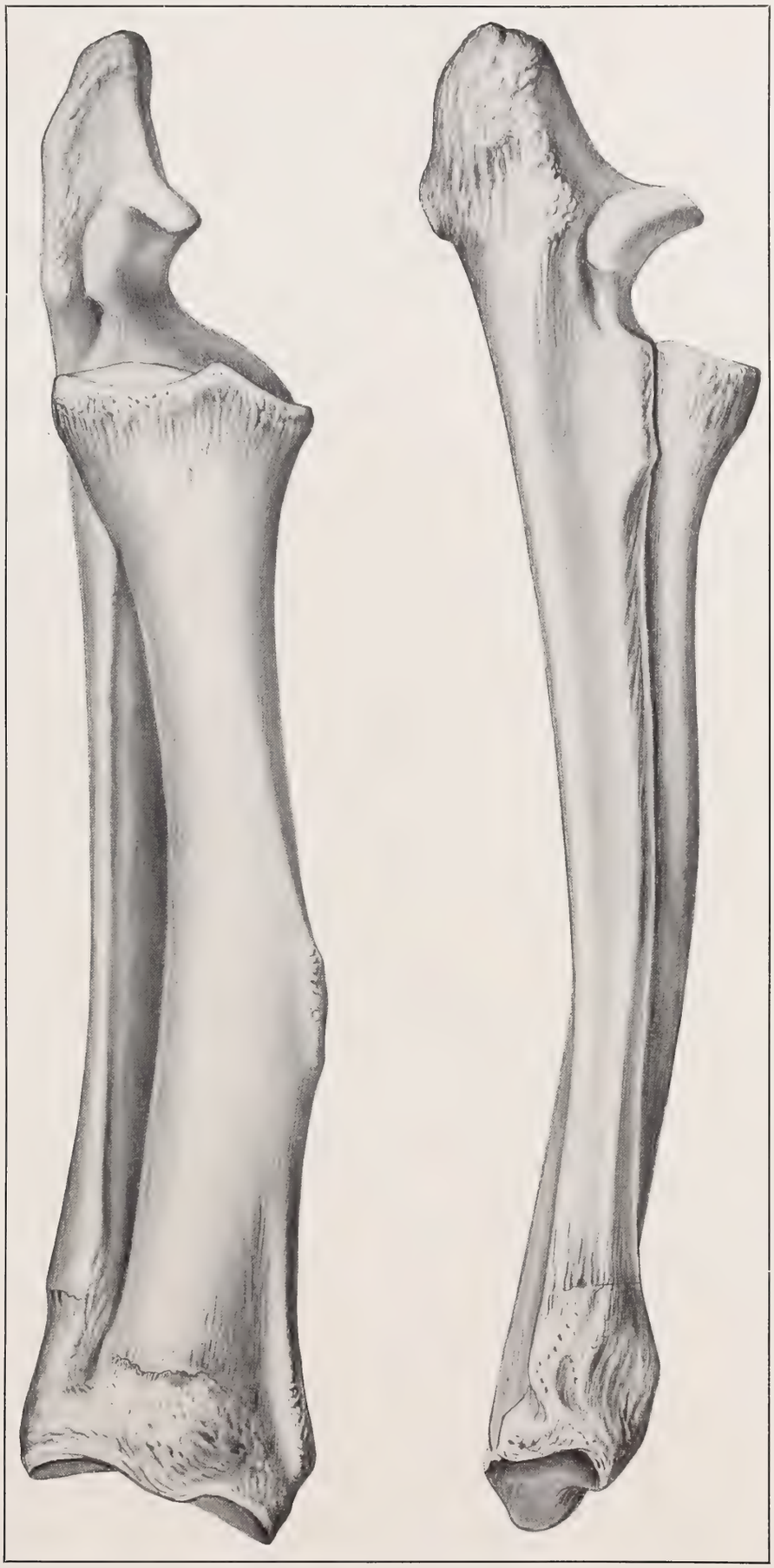
RIBS 6–10 OF *M. elatus* (No. 1604), RIGHT SIDE. ABOUT ONE-FOURTH NAT. SIZE.

RIBS 11–15 OF *M. elatus* (No. 1604), RIGHT SIDE. ABOUT ONE-FOURTH NAT. SIZE.

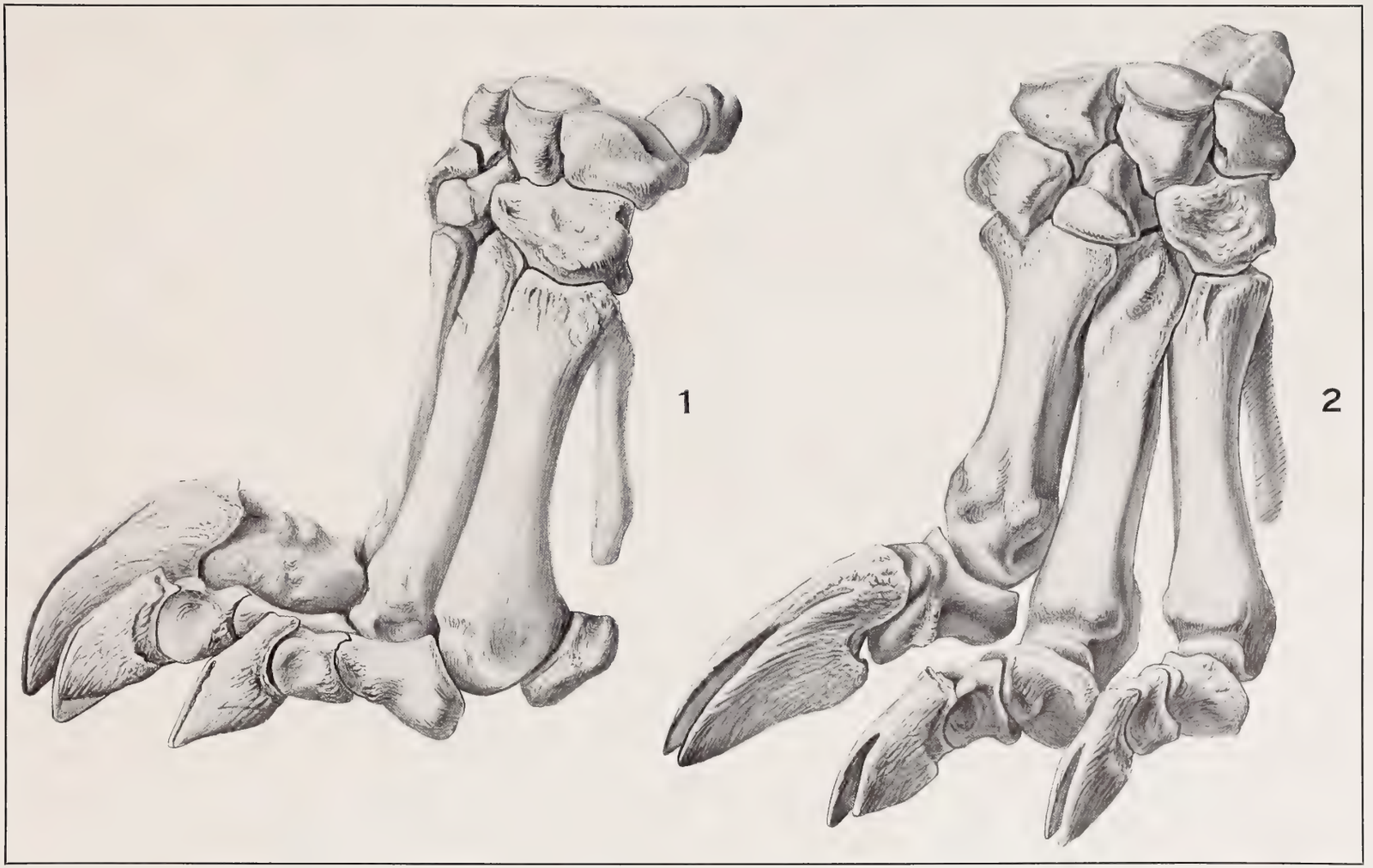


SCAPULA OF *M. elatus* MARSH (No. 1604). $\times\frac{1}{3}$.

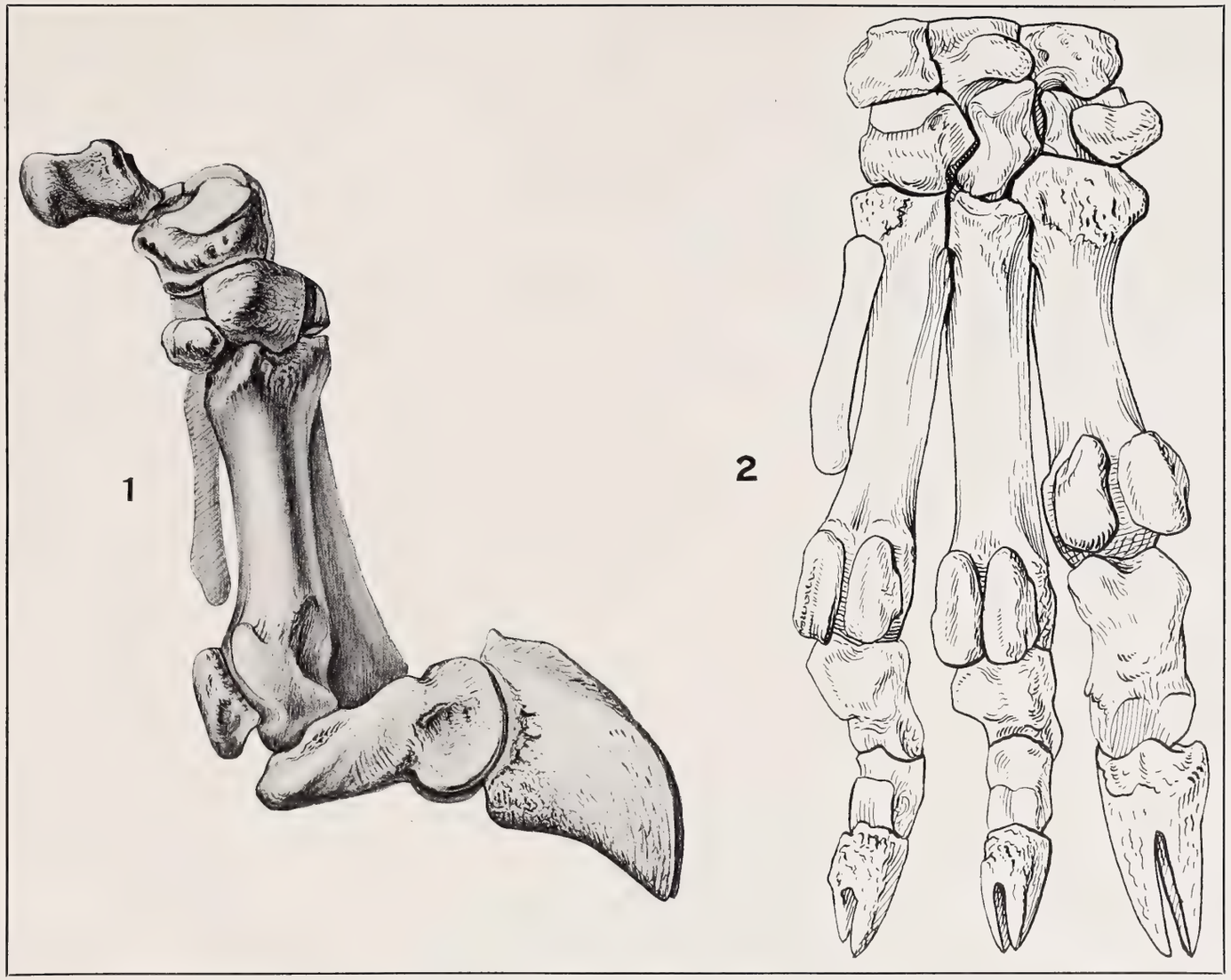
ULNAR AND ANTERIOR VIEWS OF HUMERUS OF *M. elatus* (No. 1604). $\times\frac{1}{3}$.



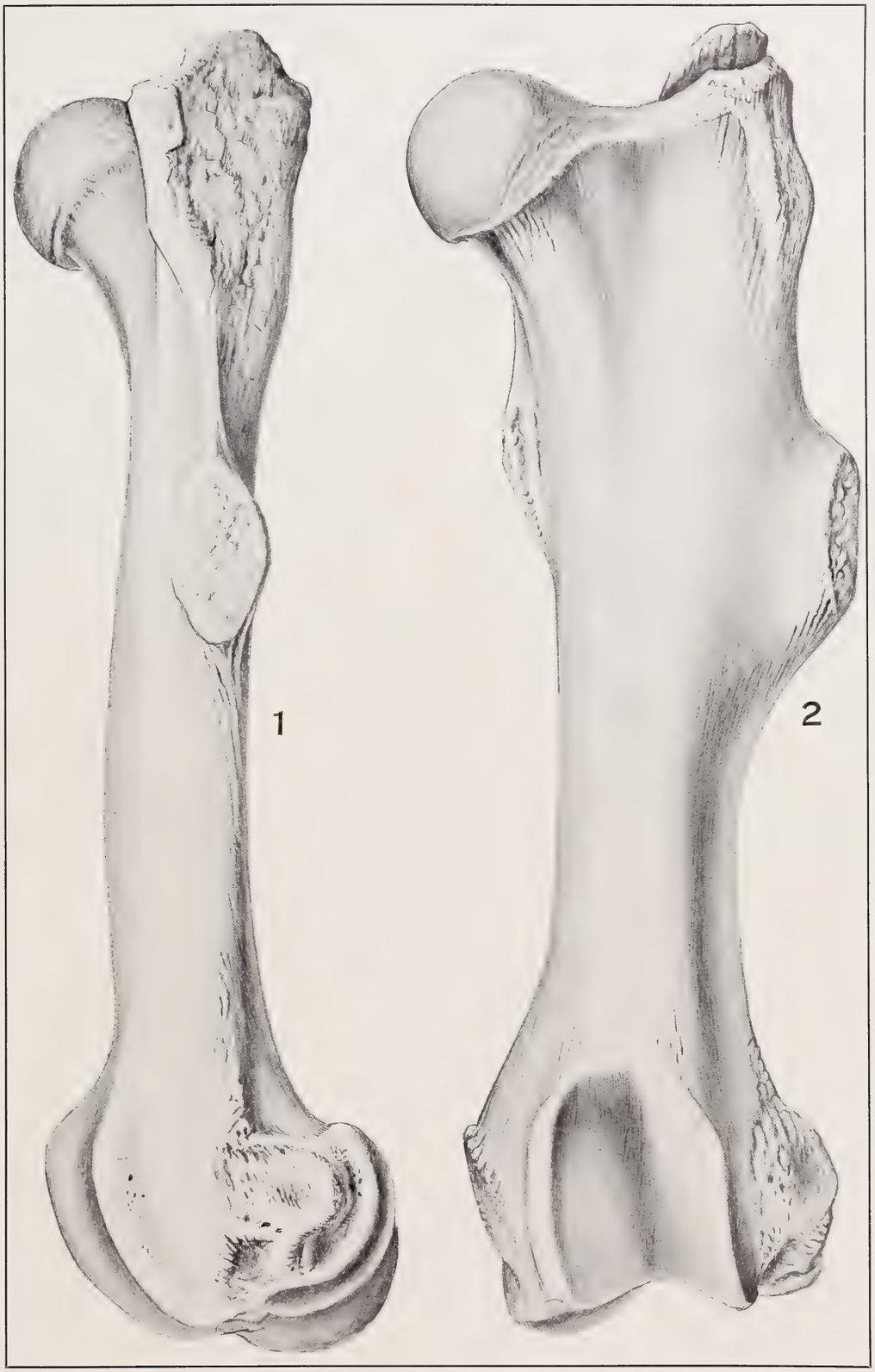
ANTERIOR AND ULNAR VIEWS OF THE ULNA-RADIUS OF *M. elatus* (No. 1604). $\times\frac{1}{3}$.



MANUS OF *M. elatus* (No. 1604). $\times\frac{1}{3}$ 1. ULNAR VIEW; 2. ANTERIOR VIEW.

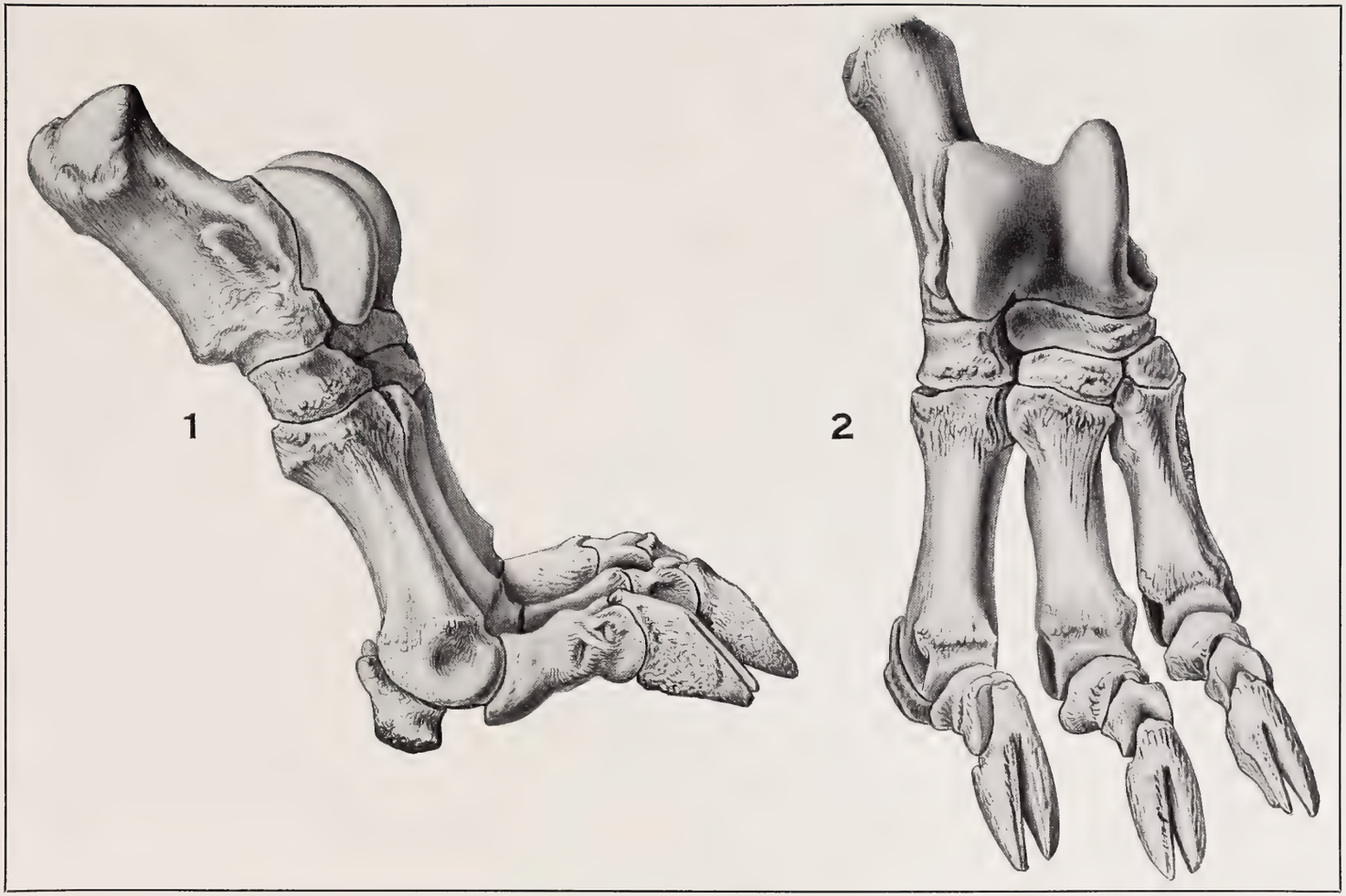


MANUS OF *M. elatus* (No. 1604). $\times\frac{1}{3}$. 1. RADIAL VIEW; 2. PALMAR VIEW.

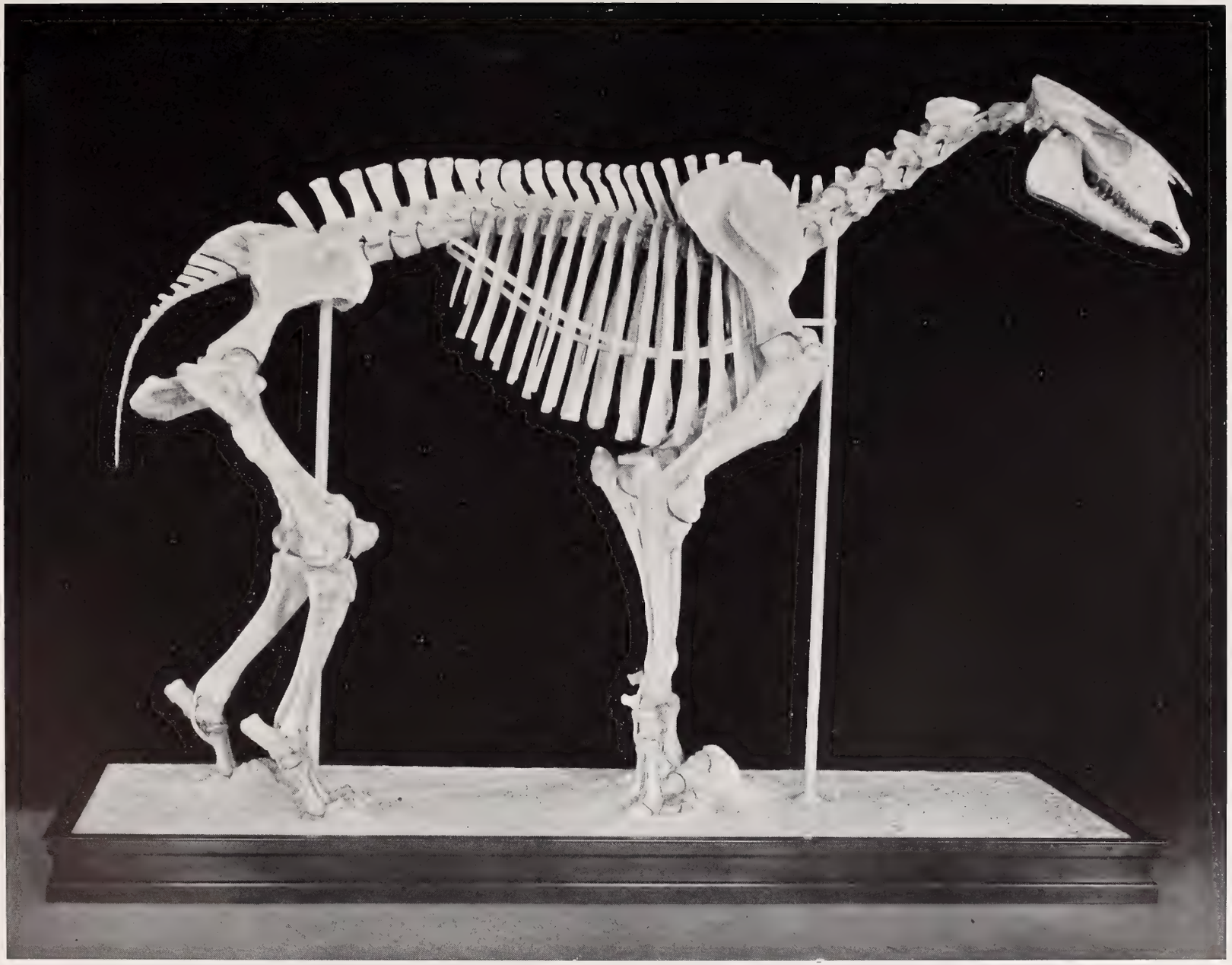


FIBULAR AND ANTERIOR VIEWS OF LEFT FEMUR OF *M. elatus* (NO. 1604). $\times\frac{1}{3}$.
1. FIBULAR SIDE; 2. ANTERIOR VIEW OF DO.

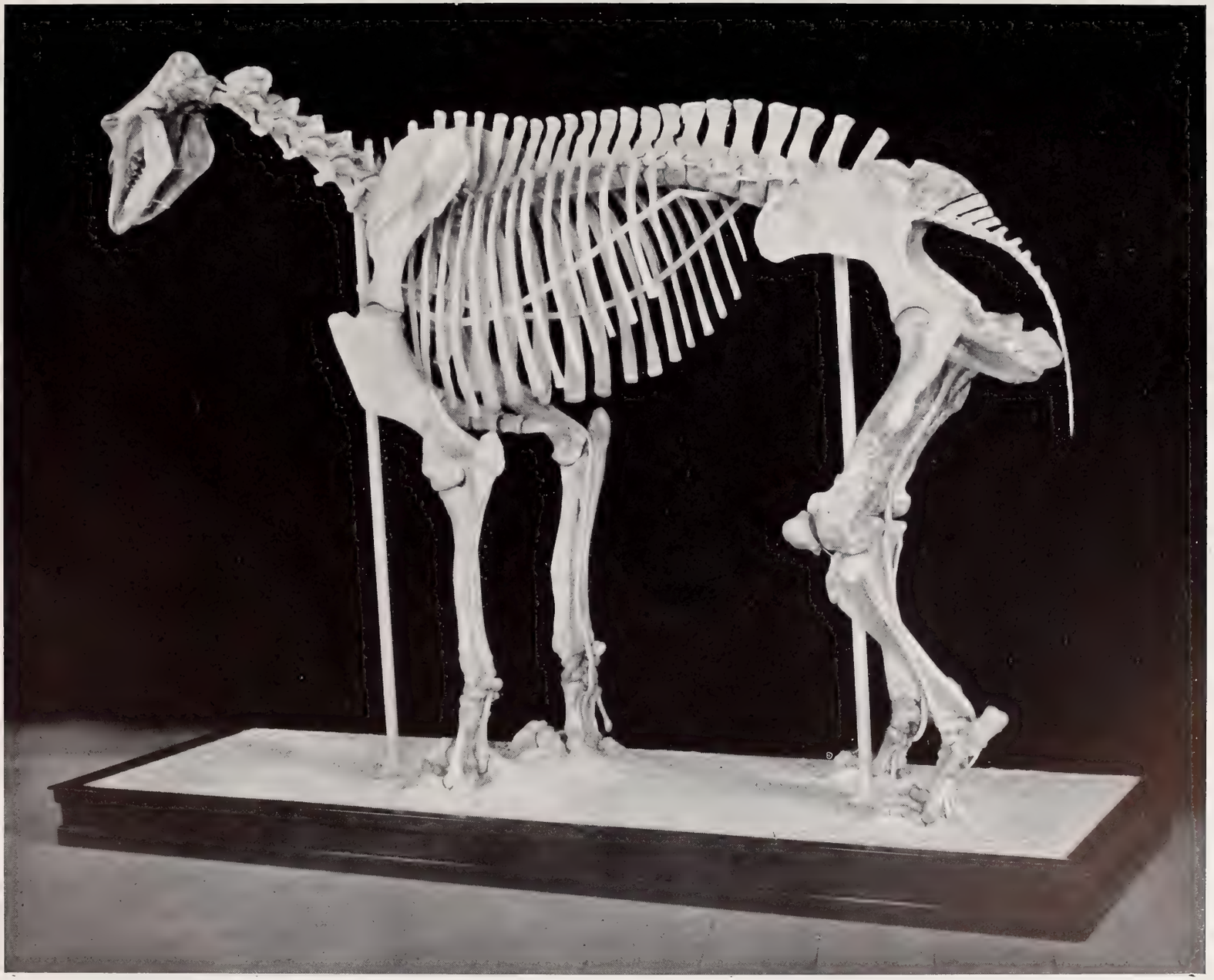
POSTERIOR, ANTERIOR, AND LATERAL VIEWS OF LEFT PATELLA; ANTERIOR AND FIBULAR VIEWS OF LEFT TIBIA AND FIBULA OF *M. elatus* (No. 1604).



RIGHT PES OF *M. elatus* (NO. 1604). $\times\frac{1}{3}$. 1. EXTERNAL VIEW; 2. ANTERIOR VIEW.

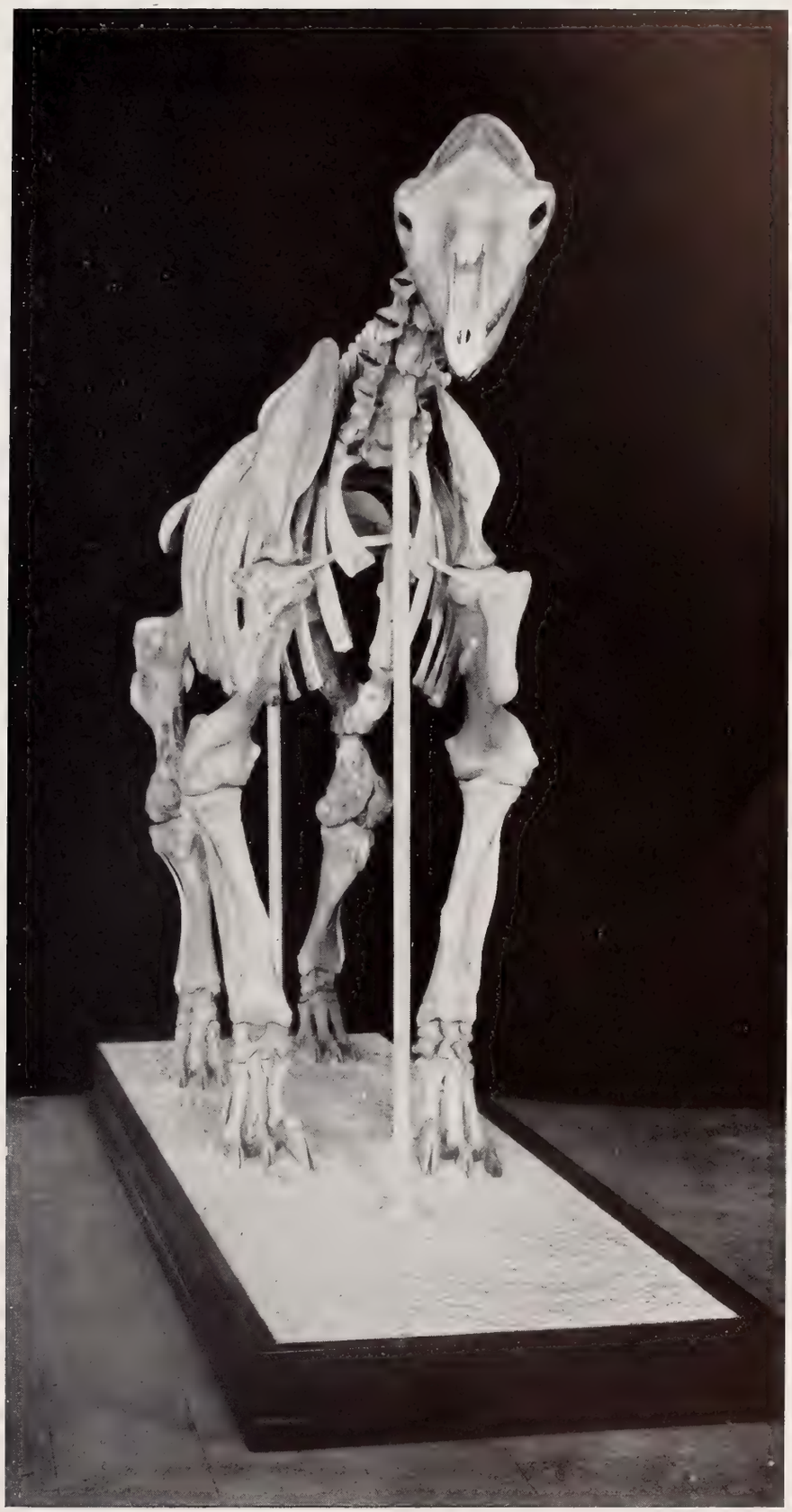


MOUNTED SKELETON OF *M. elatus* IN THE CARNEGIE MUSEUM. (VIEWED FROM THE RIGHT SIDE. ABOUT ONE-FIFTEENTH NATURAL SIZE.)



MOUNTED SKELETON OF *M. elatus* IN THE CARNEGIE MUSEUM. (VIEW OF THE LEFT SIDE FROM BEHIND. ABOUT ONE-FIFTEENTH NATURAL SIZE.)

MOUNTED SKELETON OF *M. elatus* IN THE CARNEGIE MUSEUM. (VIEWED FROM THE RIGHT SIDE IN FRONT. ABOUT ONE-FIFTEENTH NATURAL SIZE.)



MOUNTED SKELETON OF *M. elatus* IN THE CARNEGIE MUSEUM.
(VIEWED FROM DIRECTLY IN FRONT.)

MODEL OF *M. elatus* PREPARED BY THEODORE A. MILLS UNDER THE DIRECTION OF W. J. HOLLAND AND O. A. PETERSON. (ABOUT ONE-FIFTEENTH NATURAL SIZE.)

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